Intermodal Fare Integration: Application to the San Juan Metropolitan Area

by

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Abstract

This thesis considers the issues and challenges related to public transportation fare integration, both within a single operator and between different operators. The major aim is the development of a framework for analyzing fare integration strategies, as a tool for decision-makers who are considering pursuing fare integration. This framework was then applied to San Juan (Puerto Rico), both to develop specific recommendations and as a means of validating the framework.

The first step in the analysis reviewed and analyzed the related literature, to provide an overview of the major issues related both to the overall fare system and to fare integration. The second step in the analysis studied particular cases of fare integration, to develop an understanding of the state of the practice in fare integration, as well as identify some future possibilities. The cases considered were New York (NY), Washington (DC), Montreal (QC), San Diego (CA), Oxnard (CA), San Francisco (CA), London (UK), and Santiago (CH).

Based on this initial research, a framework for analyzing specific fare integration strategies was developed, to provide guidance to analysts who are evaluating potential strategies. The analytical framework proposes a set of evaluation criteria that are appropriate for analyzing fare integration. The criteria are divided into four categories: usage, financial, system, and external criteria. In addition, the analytical framework provides guidance about how an analyst might evaluate specific strategies in the context of each criteria, and gives some insight into the performance of the three major fare integration strategies (transfer discounts, period passes, and stored-value cards).

This analytical framework is then applied to the specific case of San Juan, where the public transit system is currently undergoing major changes due to the construction of a rapid transit system and the reorganization of the bus system. The framework is used to develop and analyze a series of potential fare integration strategies, resulting in a recommended time line for implementing fare integration in San Juan.

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1. Introduction

1.1 Topic Overview

For various historical and political reasons, many metropolitan areas in the United States and around the world have more than one public transportation service provider. In many cases, these transit operators are not well integrated because of a variety of physical and operational barriers. Even in areas with only one transit operator, or where one operator is clearly dominant, there is often a lack of effective integration between the different services that are offered. This lack of integration can make it more expensive and more difficult for the average transit customer to complete a trip, making public transit less attractive and potentially decreasing ridership.

One manifestation of this lack of integration is the inconvenience to travelers needing to use different vehicles to complete either a single trip or a variety of different trips. This is particularly true for vehicles of different modes or different operators, but it can be an issue even when dealing with two vehicles of the same mode operated by the same agency. Examples of inconvenient arrangements include poor physical design of transfer points, lack of schedule coordination, and inadequate, inaccurate, or missing information about other transit providers. One important area where coordination between different vehicles and operators is often lacking is fare policy, structure, and technology. This research investigates this type of coordination, commonly referred to as fare integration.

There are two major ways in which fare integration can be accomplished: by integrating fare media and technology to make it easier and more convenient to use a variety of different modes and operators, or by integrating fare pricing to reduce or eliminate the financial penalty associated with transfers. To demonstrate the reasons for implementing fare integration, it is helpful to postulate some of the potential impacts of fare integration on the user, the service provider, and society.

Looking at the first type, integration of fare media and technology, the impacts are somewhat difficult to quantify. From the perspective of riders who wish to use services provided on different modes and by different operators, there is a clear benefit in terms of

convenience and ease of use. On the other hand, for riders who do not use such a variety of services, an intermodal, inter-operator fare medium may actually complicate their trips. The societal impact of media and technology integration is also unclear. To the extent that it can induce more transit usage, either from existing riders or new riders, integration can have a positive impact, but it is not at all clear that it is reasonable to expect such an effect. From the perspective of service providers, it is difficult to determine whether media and technology integration is beneficial or not. Improved technology and fare media can result in significant cost savings in fare distribution and revenue collection, but this is largely independent of whether it is integrated between modes and operators. If it can be shown that this integration will lead to increased transit use while maintaining fare levels, this can definitely be seen as a benefit to transit agencies. However, the development and implementation of integrated fare media and technology can be costly, time-consuming, and difficult, so it is important to weigh the impacts on all stakeholders before making any decisions.

The second area, pricing integration, produces a clear benefit to users who must transfer to complete their trips. If transferring between vehicles is discounted (or free), users will save the value of the discount when they move between vehicles, which will increase their mobility and access to destinations. This can be particularly important to lower-income users, who may find the cost of undiscounted transfers onerous. Riders may even begin to chain trips together using discounted transfers, potentially increasing transit use and reducing automobile trips. This can be considered to be a benefit to society, since most communities wish to reduce car travel. However, the impact on the transit agency is unclear, and the agency's perception of the benefit will depend on their overall goals and constraints. Everything else being equal, a service provider will lose some revenue when it discounts transfers between vehicles. However, depending on the fare elasticity of riders, pricing integration may generate new ridership, which makes the revenue impact unclear. There are other potential impacts, including increased crowding and costs associated with administering pricing integration, particularly when the integration involves multiple operators. Again, it is necessary to assess all of these impacts (and others) to determine the value of a pricing integration scheme.

The purpose of this research is to investigate the integration of fare policies, structures, and technologies, both within a single mode or operator and between different modes or operators. While many studies are concerned with the extremely important technological and institutional arrangements necessary to implement fare integration, this research will attempt to take one more step to consider the potential impacts of fare integration. An analytical framework designed to assist in the process of developing and evaluating potential fare integration actions will be proposed. In addition to treating this topic in a general sense, particular consideration will be given to the San Juan area, applying the analytical framework developed to the context of fare policy and technology in the San Juan public transit system. The prospects for the public transportation system in San Juan are likely to be significantly affected by the challenge of fare integration, which makes this a particularly interesting case to consider. In particular, the system changes taking place in the context of the construction of the Tren Urbano rapid transit system provides a unique opportunity to think about improving fare integration in San Juan.

1.2 Motivation

There are two basic motivations behind this work, the first having to do with a general analysis of the choices and concepts associated with fare integration, and the second having to do with the specific application to the San Juan area.

In many situations, fare integration is studied or implemented because it is generally seen as a "good thing" that will improve public transit service and increase ridership. However, it appears that very little research has gone into quantifying the magnitude and direction of these impacts in a methodical way. As stated in the previous section, it is possible to postulate a number of different positive impacts based on experience and intuition, but these hypotheses need to be backed up with research specifically aimed at measuring these impacts and determining whether they are positive or negative. Unfortunately, it is difficult to quantify the impacts in a general sense, because of the wide variety of potential actions that can be taken and the differing characteristics of public transit agencies. The benefits are highly dependent on the particular agency and its goals, objectives, constraints, and operating situation, as well as

on the particular actions that are proposed. Given this, it is important to develop a framework for assessing fare integration strategies as a tool for decision makers. This research will therefore propose a general methodology for evaluating potential fare integration strategies in a specific context. The analytical framework will be based in part on a review of the literature and on case studies of transit agencies that are studying or have implemented innovative fare policies, structures, and technologies.

The other motivation for this research is specific to San Juan and the current and future status of the public transit system there. The San Juan system comprises a variety of different modes and operators, including both publicly operated buses and privately operated jitney services, known as públicos. In the current system, transferring between vehicles is relatively uncommon, for a number of reasons. However, current and future plans call for a change to a network structure that is much more heavily dependent on transfers. A new rapid transit system, known as Tren Urbano, is currently under construction, while changes are being made to improve the quality of the bus and jitney services. Given these changes, San Juan appears to be an area where fare integration makes sense, and where some of the benefits that have been postulated can be realized. However, as mentioned above, it is difficult to estimate these benefits *a priori*, so it is important to analyze fare integration strategies before proceeding. To do this, the analytical framework discussed earlier will be used to propose and evaluate potential fare integration strategies in the San Juan area.

1.3 Analytical Framework

When implementing fare integration, there are two major questions that must be considered: what is the range of potential fare integration strategies that can be implemented, and which of these are most appropriate in a particular situation? This research will attempt to provide a framework within which to answer these questions by identifying the impacts of the proposed fare integration strategies. This framework is designed as a tool for agencies to use in assessing the prospects for fare integration.

This framework will focus mainly on the more challenging of these questions: systematically evaluating potential fare integration strategies. The analytical framework will propose a set of evaluation criteria to be used in this evaluation process, as well a

providing some insight about how to perform this evaluation in the context of each criterion. This will provide a means of identifying the impacts of each fare integration strategy, to assist in making decisions between alternative fare integration strategies, and whether to accept or reject a particular strategy.

1.4 Thesis Organization

Chapter Two will present, as a background to the rest of the thesis, a review of the relevant literature, particularly that concerned with fare policy and fare integration. This is designed to familiarize the reader with the important issues involved.

Chapter Three will present the results of several case studies conducted of transit agencies that have interesting and innovative fare policies, structures, and technologies. This will familiarize the reader with the current state of the practice in the areas, again as a background to the rest of the thesis, and also to inform the development of the analysis framework.

Chapter Four will present the analytical framework itself. The first major section of this chapter will cover the development of a set of evaluation criteria than can be used to analyze potential fare integration strategies. The second major section will describe a basic methodology for analyzing a fare integration strategy in the context of the evaluation criteria that have been developed, with a brief description of the performance of major fare integration strategies.

Chapter Five will present the San Juan context, including a review of the current public transit system, an analysis of the reasons for studying fare integration in San Juan, and a discussion of the special characteristics of San Juan with respect to fare integration.

Chapter Six will present an analysis of fare integration strategies in the San Juan area, using the analytical framework developed in Chapter Four. The first section will briefly consider fare integration among the publicly funded modes, while the second section will focus on analyzing fare integration involving the private público services. The goal of this chapter is to develop a rough timeline for implementing fare integration in San Juan.

Chapter Seven will present conclusions and recommendations based on this analysis—both specific to the San Juan area, and general with regard to the application of the analytical framework.

2. Literature Review and Analysis

One of the most important decisions that a transit agency can make is what fare policy to adopt. Fare policy is, apart from the quality of service, the characteristic of an agency that is most apparent to riders (and to non-riders, fare policy may be *the* most apparent characteristic). A great deal of research has been conducted in this area in an attempt to gain a better understanding of the issues involved and to design better fare policies for practical application. This chapter is intended to provide a background to the topic of fare policy and fare integration and give the reader a general grasp of the issues involved. At the outset, it is worthwhile to highlight one report in particular, the *TCRP Report 10: Fare Policies, Structures, and Technologies* [1]. This recent report provides a good review of public transportation fare policy, and is an invaluable resource to anyone interested in this field. To avoid constant references to this report, which is the basis for much of the information presented here, only supplementary sources are referenced in this chapter.

2.1 Overall Fare System

In developing a fare system for a public transportation agency, there are a number of important decisions that must be made, including the price to be charged, the type of fare instrument to be used, and the method of verification. Broadly, these decisions can be broken down into fare policy and fare technology, which collectively make up the complete fare system. Within each of these broad areas, there are further areas of decision, which are described in the following sections. Following this is a brief discussion of the decision-making process and how these different options can be evaluated.

2.1.1 Fare Policy

In the area of fare policy, there are three major parameters that must be considered: fare policy environment, fare strategy, and fare structure. Together, these three elements define the general and specific policy elements that constitute one half of the fare system (the other half being technology).

2.1.1.1 Fare Policy Environment

The fare policy environment, which includes the goals, principles, and constraints that influence the development of fare policy, is referred to in many sources simply as the fare policy [2]. However, this is somewhat of a misnomer, since in practice the term "fare policy" is often used to refer collectively to all three of the areas listed above (environment, strategy, and structure). Rather, these goals, principles, and constraints really constitute the environment in which overall fare policy decision-making takes place. This environment will set the parameters for making more specific fare policy decisions, such as fare strategy and fare structure. The specific fare policy environment will be defined by the external environment in which the agency operates, including the economy, political situation, and social conditions [3], and by the internal environment within the agency, including its goals and objectives. Because of this, parts of the fare policy environment will be determined by agents and factors beyond the control of the agency, while others are fully or partially under its control.

Probably the most important endogenous element of the fare policy environment is the agency's goals, both specific to fare policy and broadly for the agency as a whole. Looking first at general transit agency goals, these can be broken down into four main categories, as described by Cervero [4]:

- **Service-Related Goals** - Goals related to the service that is being provided, including increased ridership and high quality service.
- **Management Goals** - Goals related to the manner in which the agency is managed, including improved cost efficiency and maintenance of a stable revenue base.
- **Relational Goals** - Goals related to the relations that the agency has with other entities in the region, including effective marketing of services, encouragement of broad public support, and coordination and cooperation with other agencies.
- **Community Goals** - Goals related to impacts on the community, such as energy conservation, improving environmental quality, reducing congestion, and stimulating development.

Looking at these general goals, and the role that a fare system can play in accomplishing them, Fleishman developed a list of goals specific to fare systems, based mainly on the recent experience of transit agencies:

- **Customer-Related Goals**
  - Increase Ridership / Minimize Revenue Loss
  - Maximize Social Equity
  - Increase Ease of Use and Convenience
  - Reduce Complexity
- **Financial Goals**
  - Increase Revenue / Minimize Ridership Loss
  - Minimize Fare Abuse and Evasion
  - Improve Revenue Control
  - Reduce Fare Collection Costs
  - Increase Prepayment / Reduce Use of Cash
- **Management-Related Goals**
  - Improve Data Collection
  - Improve Modal Integration
  - Increase Pricing Flexibility
  - Maximize Ease of Implementation
  - Improve Fleet / Demand Management
  - Improve Reliability of Fare Equipment
  - Improve Operations
- **Political Goals**
  - Maximize Political Acceptability
  - Achieve Recovery Ratio Goal / Requirement

Again, one can argue over the form of the specific goals, but overall this represents a useful framework for looking at this portion of the fare policy environment. These fare policy goals will often conflict, increasing the difficulty of developing a coherent and consistent fare system.

The other major element of the fare policy environment is the set of constraints that limit the agency's possible actions. It does not appear that anyone has attempted to define these constraints, although the goals listed above implicitly define some of them. It is difficult to define these constraints in a general way, because they are highly dependent on the local conditions that exist around a transit agency. In general, three types of constraints may exist:

- **Constraints Within the Agency** - Management practices, labor agreements, or organizational structure may limit an agency's decisions about its fare system.
- **Constraints in the Transportation System** - Interactions with the general transportation system will also constrain fare policy decisions. The decision-making process will need to take into account issues such the competitive position with respect to other modes and the possibilities for greater intermodal integration. These constraints may not be felt as directly as those that are internal to the agency, but it is still important that they be taken into consideration.
- **Societal Constraints** - Society as a whole (and the accompanying political, social, and economic system) can impose heavy constraints on the fare policy decisions that are possible.

Once the fare policy goals have been determined, and the constraints identified, the agency can move on to the next step, the determination of an appropriate fare strategy.

2.1.1.2 Fare Strategy

Fare strategy describes the general fare payment and collection approach, excluding determination of pricing levels. There are five general pricing strategies:

- **Flat Fare** - This is the simplest fare strategy, involving the payment of a single price for travel, regardless of the distance, service, or time [2].
- **Distance Based** - Under this strategy, the fare paid is based on the distance that is traveled by the passenger, either finely graded to exact distance, or more coarsely according to zones. This strategy is based on the fact that a longer trip generally costs more to provide and that the value of the trip is higher. When taken to

extremes, this strategy can be very complicated for both the passenger and the operator [2].

- **Time-Based** - Using this strategy, prices are based on the time of day and/or day of the week when the trip is made, with the off-peak (outside rush-hour and on weekends) priced lower than the peak. The rationale behind this is twofold: first, it is more expensive to operate service during the peak period, and second, elasticities are lower during peak periods, both of which make higher peak fares attractive.

- **Service-Based** - Pricing is based on the quality of the service that is provided. A common example is higher prices for express service, to reflect both the higher quality of service and the greater costs. Another reason that this model is attractive is that studies have shown riders are more responsive to changes in service than to changes in fare, so they may be willing to pay considerably more for improved service [5].

- **Market-Based** - Market-based pricing differentiates between consumers on a willingness-to-pay basis, as a means of maximizing revenues. Transit riders are divided into market segments, and different fares are charged for each segment, based on the willingness to pay of people in that segment. The most widely known form of market based pricing in the transit industry is deep discounting, where discounts are targeted at the high-elasticity passengers (such as infrequent and off-peak riders) whose travel patterns are more sensitive to price [6].

These various fare structures are by no means mutually exclusive, and different approaches can be combined to produce the desired results. In addition to determining the basic pricing strategy, decisions must be made about the pricing of fare integration instruments between modes. The basic options available are free transfers, discounted transfers, or full payment for boarding each separate vehicle; these will be discussed in greater detail later in this chapter.

In addition to pricing strategy, the other strategic element that must be decided is what payment options will be made available to riders. Without looking specifically at the technologies, these options can be broken down into the following:

- **Single-Ride** - The rider pays for one trip at a time, without any discounts. In many cases, payment for a single ride involves payment of the exact fare in cash.
- **Multi-Ride** - With a multi-ride instrument, riders can purchase some number of rides at one time. The advantages of this are convenience of purchase and, frequently, a discount provided on bulk purchases (as described above under market-based pricing).
- **Period Pass** - The rider is sold an instrument that allows him or her unlimited rides on the system for some limited period of time (ranging from less than one day all the way to one year). This provides convenience of purchase, as well as cost savings for riders who make a large number of trips.
- **Stored Value** - With a stored value card, a certain number of rides or a certain amount of money is encoded on the card, and then deducted when a trip is made. This offers many of the convenience advantages of a period pass without the revenue loss those entail in the case of high volume riders.
- **Post Payment** - Post payment involves the rider being charged for traveling after the trip is made, by some billing method. Although this type of payment is widely accepted in many industries, it has not been popular in the transit industry, for a variety of technical and operational reasons.

As with the pricing strategies, all of these payment methods can be mixed and matched to create a fare system that best meets the needs of a particular agency. Different instruments are available for use in fare integration, and these will be discussed at greater length in later sections.

2.1.1.3 Fare Structure

Once a determination has been made about the fare strategy that will be used in a particular fare policy environment, decisions must be made about the specific fare

structure. The development of the fare structure must take into account both the agency's goals (as discussed earlier), as well as general economic principles about pricing of a public utility. Designing a fare structure will include making decisions in the following general areas:

- **Single-Ride Fare** - This defines the basic cost of riding the system. This can be on a system-wide basis in the case of flat fares, or according to the market segments used in the various differential pricing strategies. Decisions must also be made about discounted pricing for students, seniors, and/or handicapped riders.
- **Bulk Discount** - In the case where an agency is providing a bulk discount, a determination must be made about the level of discount, taking into account economic, political, and social factors.
- **Transfer Pricing** - If some sort of discounted transfer privilege is to be offered, decisions must be made about the transfer price and length of validity.
- **Pass Break-Even Rate** - To determine the pricing of passes, the agency must decide the number of single rides each pass is equivalent to. This determination will depend on a number of factors, including the financial situation of the agency and its specific policy goals.

There are a number of other decisions that an agency must make with regard to fare structure, but these are the major areas.

At the same time that an agency is looking at fare policy, it must also consider the fare technology options, since the technology can limit the possible fare policies and, conversely, the desired fare policy will often drive technology procurement.

2.1.2 Fare Technology

Turning to the issue of the technology that is used in a fare system, there are two major categories: fare technology used by the riders (fare medium) and fare technology used by the agency (fare equipment). In addition to these two technology issues, the agency must decide how it will verify fare payment, which constitutes the interaction between the fare medium and the fare equipment (options include entry control and proof

of payment). The technology that is used will influence a number of the goals described earlier, including convenience, revenue control, data collection, and reliability.

2.1.2.1 Fare Medium Technology

A number of different methods are available whereby passengers may gain entry to the system. For many years these were restricted to cash, tokens, and tickets, but in the past three decades there has been a slow but accelerating switch to more sophisticated technologies such as magnetic stripe cards and, more recently, smart cards. These are the major fare medium technologies currently in use:

- **Cash** - Cash used directly as a fare medium is the oldest, most common medium used in public transit. However, cash presents a number of disadvantages and difficulties, including the need for exact change (increasingly problematic in the past thirty years), difficulty in handling paper currency (in the United States), and problems with accounting and theft [7]. But even with all these problems, cash is likely to remain an important fare medium for the foreseeable future.

- **Token** - Tokens are coin-like fare instruments that are valid for one fare, and are used for payment in place of cash. Tokens are convenient for passengers to buy and use, and can be processed easily, but they are easily counterfeited and can be hoarded by users (making it difficult to change fare structure on a frequent basis). Tokens are principally used on older and larger systems, but they can be found throughout the public transit industry.

- **Ticket** - Similar to tokens, tickets are sold by the agency as a proxy for the payment of one fare, with the ticket being surrendered upon entry. Tickets, which are sold singly or in bulk, can be preprinted or printed at the time of sale, with the information encoded either visually or magnetically, or both.

- **Passes** - Passes are a fare medium that give the holder unlimited system rides during the period of validity. As with tickets, passes can be encoded with visual or magnetic information (or both), and are verified either visually or by a machine that reads the magnetic information.

- **Stored Value Cards** - With a stored value card, an amount of either rides or money is electronically stored in the card, and some of that value is deducted with each trip taken. This can provide a great deal of flexibility in fare structure, since different amounts can be deducted depending on the characteristics of the trip and the rider. This makes it possible to utilize more complicated fare strategies and structures without making the system too burdensome to users. Stored value cards take two main forms: magnetic stripe cards, where the stored value is encoded magnetically, and smart cards, where the stored value is encoded in a computer chip inside the card. Smart cards also come in two varieties: contact, where the information is passed to the fare collection system by contact between the card and the fare equipment, and contactless, where the card communicates with the fare equipment using radio communications [8]. Smart cards are currently receiving the most attention of any fare medium, and they are likely to have significant impact on all aspects of public transit fare systems in the future.

2.1.2.2 Fare Equipment Technology

The technology available for use by agencies in issuing and collecting fare media also covers a wide ground, with the technologies in use ranging from simple fareboxes all the way to contactless smart card readers. As with fare media, this area has seen rapid technological development in recent years, in response to both the developments in fare media and the need for greater flexibility on the part of public transit agencies. The most commonly used pieces of fare equipment include:

- **Ticket-Vending Machines** - Ticket-vending machines (TVMs) are passenger-operated, self service machines where various kinds of fare media can be purchased, using cash and in some cases credit and debit cards. TVMs are available with a wide variety of options in the types of medium sold, the denominations that are acceptable, and the passenger interface. TVMs can be used to vend everything from a token to a smart card, and can be used for any public transit mode. Automatic teller machines (ATMs) operated by banks, both on and off the transit property, can also be used as TVMs.

- **Validators** - Validators are equipment used to validate or cancel a ticket or pass that has been previously purchased, to indicate its period of validity. In the case of a ticket, the validator will cancel the ticket so that it can't be used again; for a pass with a variable starting date, the validator will indicate when the rider began using the pass.

- **Ticket Office Machine** - A ticket office machine (TOM) is used by agency personnel at locations where tickets are sold. Usually resembling a cash register, the TOM will take input from the operator about the fare that is being purchased, and then encode the necessary information into some type of fare medium. The medium is dispensed to the operator, who will then give it, along with any change, to the customer making the purchase. TOMs speed up the sales process as well as making the process of accounting for the revenue collected and fare media sold much easier and more reliable.

- **Ticket Processing Units** - Ticket processing units (TPUs) are devices that issue and accept magnetically encoded tickets and transfers. These are usually attached to fareboxes, making it easier for the operator to verify the validity of the ticket or transfer or to automatically issue a transfer when the appropriate amount is deposited in the farebox. TPUs can make the operator more reliable as a fare medium acceptor, while improving the quality of the passenger data that is collected.

- **Fareboxes** - Fareboxes are used on board vehicles to accept physical fare medium from the passenger, which is then deposited into a locked vault where it is secure from theft. Most modern fareboxes are electronic registering fareboxes (ERFs), which count the fare medium deposited and verify that the appropriate amount has been deposited. This farebox data can also be used to estimate the number of passengers, particularly with the help of information (such as route, direction, and passenger type) that is input manually by the vehicle operator.

- **Fare Gates** - Fare gates are used to control access to some transit systems, such as many rapid transit systems. As with a farebox, the turnstile will accept the fare

medium and store all medium deposited in a secure location within the equipment. Once the fare medium has been counted and/or verified, a gate is released or opened, providing access to the system [7]. In the case of cards and passes, the medium can either be swiped through a reader, or be transported through the machine and then retained or returned. Some fare gates also have the ability to print on medium while it is being transported through the equipment. Like fare gates, turnstiles can be valuable sources of ridership information.

- **Hand-Held Devices** - In an effort to improve the flexibility and usability of various fare media, hand-held ticket devices (HHTDs) have been developed for the sale, acceptance, and verification of fare media by personnel in the field, such as proof-of-payment inspectors [7]. In addition, the development of portable communications devices, such as cellular phones and pagers, has increased the feasibility of remote communication and data collection, making it possible to monitor the status of fare collection personnel and equipment more reliably.

2.1.2.3 Fare Payment Verification

The final element of fare technology that must be considered is the method used to collect the fares and control access to the system. This is considered to be an aspect of fare technology, because it is the point of intersection between the fare medium and fare equipment. There are four main fare collection methods:

- **Pay-On-Entry** - Pay-on-entry collection, which is used principally on buses, involves the passenger paying the fare, usually into a farebox, as they enter the vehicle. This is simple to administer and is easy for passengers to understand.
- **Barrier** - Under a barrier system, the transit system is "closed," and riders must pay as they enter the station area. This involves the use of ticket agents and fare gates to ensure control of the paid area. This approach is most common on rapid transit systems, where it is most feasible to restrict access to the paid areas.
- **Proof-of-Payment** - With a proof-of-payment (POP) system, the rider is responsible for having a valid fare medium (usually a validated ticket or pass)

when they enter the fare control area or board the vehicle. Passengers are then subject to random verification of the validity of their fare medium, and are subject to a fine if they have not paid. Under this system, only a fraction of the riders will have their fares checked, but the vast majority will pay because of the potential consequences of not having a valid fare medium with them. This system is used on some newer light rail systems in North America, and is common in Europe.

- **Conductor-Validated** - Used most commonly on commuter rail, this system involves having conductors on board the vehicle accept payment for travel. This is different from POP in that the conductor is not verifying the validity of the fare medium, but rather selling tickets and accepting payment. In this way, all passengers are checked and required to pay (at least in theory).

The three major elements of fare technology (medium, equipment, and payment verification) can be combined to meet the requirements of a specific agency. Almost any fare medium can be used in any of the verification methods; on the other hand, different types of fare collection will require different equipment. As mentioned earlier, all of the elements of fare policy and fare technology are strongly interrelated, making decision-making a difficult process that requires a number of feedback loops in order to develop a system that best meets a particular set of needs. The following section discusses this decision-making process and reviews a methodology that can be used to structure it.

2.1.3 Fare System Decision-Making

Given the wide range of options available for the creation of a fare system, it is important to have a methodology and framework for fare system decision-making. This provides the agency with a rational process for making fare system decisions, which should result in better decision-making and the implementation of improved policies and technologies. Cervero [4] and Fleishman have both proposed frameworks for making fare system decisions, each of designed to provide agencies with a structured process. Fleishman's proposed framework is intended to be very general, and provides a good outline of an idealized process. Not all agencies will go through the entire process, but

they will likely be able to pick out a section of the methodology that they can apply in their particular context.

Figure 2-1 presents Fleishman's methodology, with the terminology adjusted to match that used in this research.

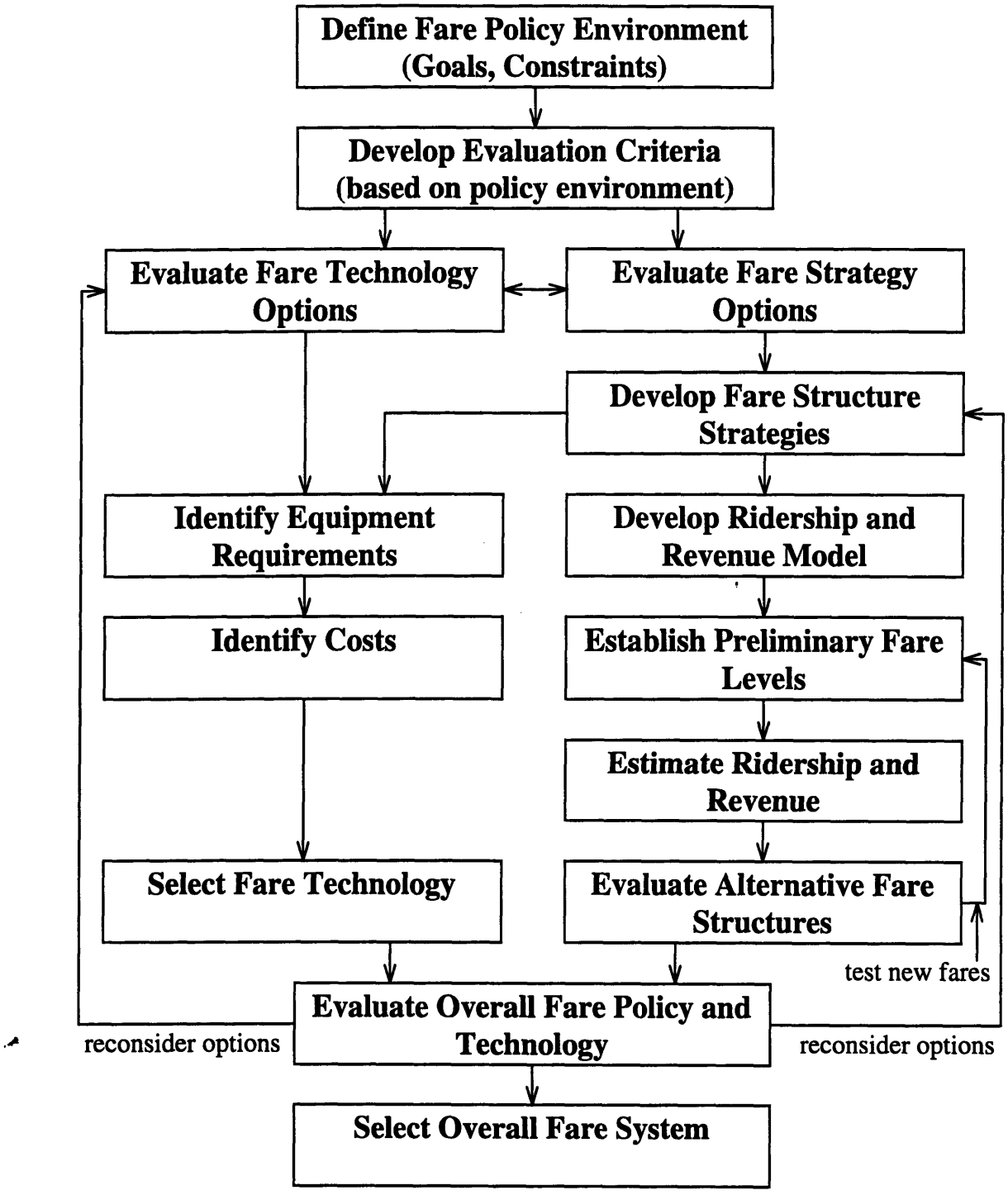

Figure 2-1: Fare System Decision-Making Framework

In addition to looking at the decision-making process, it is also important for an agency to consider the environment in which it is making fare system decisions, along with their underlying motivation. Based on experience at transit agencies, Fleishman defines three major scenarios under which an agency will be making fare policy decisions:

- **Policy-Driven** - In this case, the agency has established a new set of goals and objectives, and needs to implement a supportive fare system.
- **Technology-Driven** - When an agency acquires new technology, it will often wish to revise its fare system so as to take advantage of it. Although the agency would ideally make the determination of technology and policy simultaneously, the technology is often a fixed input to the decision-making process.
- **Service-Driven** - When an agency introduces a new service, or substantially reorganizes its current services, there is often a need and an opportunity to introduce a new fare system. This is also true in the case of a new agency, which is either continuing existing service or introducing a completely new service.

Depending on the decision-making scenario, different elements of the fare system will have to be taken as fixed, although there may be times (particularly in service-driven decisions) where it is possible to remove almost all constraints from the decision-making process. However, in all cases one must take into account the existing fare policy environment, which will place a set of constraints on the fare system to be developed. The decision-makers also need to take into account the temporal element of these decisions, and how they interface with other actions that are taking place at the agency.

2.1.4 Fare Policy Evaluation Criteria

One of the important elements of the general fare system evaluation process shown in Figure 2-1 is the second box, the development of evaluation criteria, based on the goals and constraints on the agency and the fare system. Definition of criteria defines what is important to the agency performing the evaluation, and will guide the subsequent evaluation process (as well as determining what data is required). Fleishman defines a set

of criteria that can be used to evaluate the different aspects of the fare system. The following sections describe these criteria, as a prelude to developing a set of evaluation criteria that can be used specifically for evaluating fare integration strategies. Fleishman divides these general criteria into three categories, customer, financial, and management / political:

2.1.4.1 Customer Criteria

- **Impact on Ridership** - Changes in the fare system will produce changes in ridership, with price increases generally leading to decreases in ridership and vice versa. However, the relationship is not quite that simple, particularly with recent innovations such as deep discounting. This is an important impact, both in its direct form and because of the related effect on revenue (discussed in the next section).

- **Impact on Equity** - Changes in fare policy do not always have an equal effect on all riders, which can lead to an unfair burden on certain sectors of the populations, such as low-income and elderly riders. In many systems, wealthier residents tend to make longer trips, but pay the same amount as lower-income residents who may make shorter trips in the central area. One of the major problems in analyzing equity is that there is little agreement on the proper definition. Equity can imply that all users are treated equally, or it can mean that disadvantaged users are given extra assistance. Equity can also be looked at specifically in the context of the service that is provided, or more broadly in terms of the benefits that result from that service. It is therefore important to make a decision about how equity will be defined before proceeding with any analysis.

- **Convenience** - Convenience relates to ease of use, and to how simple it is for riders to use the fare system that is in place. This is an important consideration, because fare policy is an important element of the public image of a transit system. An example of this is the requirement for exact change on buses, which is not particularly convenient for riders, and can constitute a barrier to use of public transit, particularly for casual users. This example also illustrates the need to consider the experience of riders, since convenience will have a different meaning depending on whether a passenger is

a regular, casual, or new rider. Many of the current innovations that are taking place in public transit fare technology (and to some extent, fare policy) are aimed at increasing convenience.

- **Range of Options** - Changes in the fare system will often change the range of fare options available to riders. This is related to the issue of convenience, since increasing the available options usually enhances convenience. However, at a certain point, increasing the range of options will result in a fare system that is too complicated. These two elements must be carefully balanced to create a fare system that is flexible yet easy to understand.
- **Complexity** - Fare system complexity is related to a potential rider's ability to understand the fare system. As with convenience, this can be either a barrier or an enticement to use, with a complicated fare system making it less likely someone will decide to use public transit. This can also be an issue of access to information: it can often be difficult for occasional riders to know the intricacies of the fare system, which adds a further barrier to using public transit.

2.1.4.2 Financial Criteria

- **Impact on Fare Revenue** - As far as potential changes in revenue are concerned, the most important type of fare system change is changes in pricing, which will have an impact in two ways. First, it will lead to a change in ridership, whose extent will depend on the elasticity of the riders. Second, the revenue per rider will change as a direct result of the original change in price. Because many public transit agencies are under financial pressure, this revenue impact is important and needs to be considered carefully. However, there are a number of societal benefits (such as reduced congestion and improved air quality) that accrue from increased ridership, which will help to mitigate the negative revenue impact of lower fares.At the same time, it is important to consider the fact that ideally, every revenue dollar lost by the agency is another dollar that is still in the pocket of riders, which is in itself a public benefit. Since public transit providers are generally public entities, this benefit may mitigate

the negative impacts of revenue loss (or the benefit of revenue increases), thereby decreasing the importance of this criterion.

- **Impact on Fare Abuse / Evasion** - Public transit agencies are concerned with the risk of fare evasion by riders and fare abuse by employees. This concern arises both from the direct revenue impact and from the negative image that this projects. Many of the new fare system technologies may reduce these risks through better control and accounting. In addition, fare policy changes can also exert influence in this area, since pricing and fare collection method can change the opportunities for abuse and evasion.

- **Impact on Fare Collection Costs** - In evaluating a fare collection system, an important area to take into account is the implementation cost, both capital costs and ongoing operating and administration costs. Many agencies are considering implementing new fare technologies that have high capital costs, but can reduce operating costs substantially and improve the effectiveness of personnel. It is also important to consider the impact on the existing labor force, inasmuch as decreases in cost often come from reductions in the labor required.

- **Impact on Prepayment** - Many public transit agencies wish to reduce the use of bills and coins in their systems, because of the cost of counting and transporting them. This has led to many attempts to increase the use of prepayment so that money and accounting can be handled centrally. It is hoped that this will reduce costs and keep the stream of money more secure from abuse by employees.

2.1.4.3 Management / Political Criteria

- **Ease of Implementation** - When changes are planned in the fare system, there are always concerns about implementation. The changes often necessitate major physical alterations, including replacing or modifying fareboxes and modifying stations. When policy changes are being made, both riders and vehicle operators / station attendants must be informed about these changes. In both cases, training and education are required to ensure that the fare system is used correctly. In addition, one must

consider how the transition will take place, and how the existing system will remain in place while changes are being implemented.

- **Impact on Fleet / Demand Management** - Changes in pricing can change people's behavior, for example by encouraging them to travel during times when service is less expensive. An example is higher prices during the peak hours, which are the most expensive times to provide service. By shifting demand out of these hours, it is possible to reduce costs and increase the utilization of the agency's vehicle fleet.
- **Political Acceptability** - Given that public transit agencies often operate in an intensely political environment, their actions must be acceptable to the politicians who have control over important parts of their capital and operating budgets. Changes to the fare system, in both policy and technology, often arouse political opposition, particularly when it results in price increases. Because of this, agencies should consider the likely political response before seriously considering changes in the fare system.

2.1.4.4 Additional Criteria

In addition to reporting these general evaluation criteria, Fleishman also performed case studies of a number of transit agencies, and the processes that they used to evaluate changes in fare structure and technology. Overall, the criteria used by these agencies are covered by the general criteria proposed by Fleishman, although there are some notable exceptions that may be of interest (the agency / agencies that used each criteria are included in parentheses):

- **Public Acceptability** (Chicago Transit Authority, Orange County Transportation Authority, Dallas Area Rapid Transit) - As well as considering the political acceptability of a fare strategy, it is also important to consider the direct public acceptability. Although political acceptability may often mirror public acceptability, the two criteria are not necessarily congruent.
- **Risk** (Chicago Transit Authority) - Whenever changes are made to an agency's fare strategy, there is some risk involved, because the strategy is not guaranteed to work as

expected (due to factors such as technology problems or lack of acceptance). It is important to consider this risk explicitly, particularly since fare system failures tend to be very visible.

- **Management Information** (Chicago Transit Authority) - With increasingly sophisticated fare equipment (combined with other Intelligent Transportation Systems technologies), fare equipment can be an important source of information for planning and management. In this environment, an agency that is making changes to its fare system should assess how these changes will affect the management information that will result.

- **Compatibility with Other Assets** (Dallas Area Rapid Transit) - Before implementing a new fare strategy, an agency should consider how this change will interact with the other assets that the agency has in place. This should include not only fare equipment, but also rolling stock, station layout, and service design, all of which affect the fare system.

- **Operational Impacts** (New Jersey Transit, King County Metro, Miami Valley Regional Transit Authority) - Any changes in fare system can have a number of important effects on the operations of a public transit agency. Operationally, fare strategies can affect passenger boarding and vehicle dwell times, as well as the maintenance program. In addition, changes in fare collection can affect the relationship between labor and management, and may engender resistance from vehicle operators and station attendants (particularly if their responsibilities increase).

- **Ability to Integrate Modes** (Bi-State Development Agency, Southern California Regional Rail Authority) - Clearly, changes in fare strategy can impact the ability to integrate different modes. Transit agencies must consider these effects, and weigh them against other goals to decide what actions they will pursue.

- **Marketing Support** (Madison Metro) - Given that fare policy and strategy is a very public characteristic of a transit agency, decisions in these areas interact with the marketing plan and can create new opportunities or obstacles. It is therefore necessary for agencies to consider their marketing goals in making fare system

changes. The importance of this criterion will depend on the importance an individual agency places on marketing.

2.1.5 Organization of Criteria

Although there is some logic to the categories Fleischman used to organize these evaluation criteria, there does not appear to be any overriding rationale for these divisions, and it is difficult to justify some of his choices. For example, although ridership clearly involves customers, it is not truly a customer criteria; rather it is related to the financial and operational performance of the agency. The major problem with this organization seems to be that they do not reflect any deeper reality about the divisions among the criteria, leading to a structure that is not particularly useful to an analyst.

For the purposes of this analysis, it is useful to organize these criteria in a more general framework. For the remainder of this research, the criteria are divided between internal and external, to reflect an important real-world division. Within these two broad categories, sub-categories are used to provide more structure, but the division between internal and external is taken to be the most basic one. The following section summarizes the categorization scheme used throughout the remainder of this research.

2.1.5.1 Internal Criteria

Usage Criteria

- Ridership
- Demand Management

Financial Criteria

- Fare Revenue
- Fare Collection Cost
- Fare Abuse / Evasion
- Prepayment

- Risk

System Criteria

- Operational Impacts
- Management Information
- Compatibility With Other Assets
- Ability to Integrate Other Modes
- Marketing Support
- Ease of Implementation
- Range of Options

2.1.5.2 External Criteria

- Equity
- Convenience
- Complexity
- Political Acceptability
- Public Acceptability

The previous sections have provided an overview of the major elements involved in developing a fare system, as well as describing a methodology that can help in this decision-making. The second half of this chapter turns to an element of fare policy that is not nearly as well understood (and the overall topic of this thesis), fare integration.

2.2 Fare Integration Policy

As discussed in the previous section, the general topics of fare policy and technology are reasonably well understood, although ongoing technological developments are changing this understanding to some extent. However, the specifics of fare integration itself are not as well understood, due both to a lack of general knowledge and

to a lack of analytical treatment. In particular, there does not appear to be a good understanding of the impacts (both positive and negative) of fare integration. Although some work has been done to elucidate the implementation issues associated with fare integration, the process is generally just regarded as a "good thing," without a great deal of analytical basis for that judgment. A paper on fare integration by Kerman [9] illustrates this problem. Fare integration is credited with the ability to provide riders with more choices, improve operating efficiency, and increase ridership, in this case in the Chicago area. Although these benefits may in fact be real, no analytical basis is provided, weakening the conclusions. Carter and Pollan state that, "making a total trip easier for customers through joint fares is believed to have a positive impact on increasing market share", but again the analytical support for these advantages and disadvantages is unclear [10]. Some agencies have made attempts to isolate the impacts of fare integration strategies after they have been implemented (London provides a good example of this). However, these analyses seem to be rare, because it can be difficult to separate out effects that are specific to fare integration from those that result from other fare policy actions or unrelated factors.

The principal goal of this thesis is to attempt to remedy this problem by developing a framework for analyzing the impacts of fare integration. To do this, it is important to understand what fare integration is and what tools are available for accomplishing it. Throughout this thesis, fare integration is defined as:

> *Actions taken with respect to fare policy and fare technology that facilitate movement between vehicles. These vehicles can be of the same or different modes, and may be operated by a single operator or by different operators.*

Note that this definition includes both intra-operator fare integration and inter-operator fare integration. The first type of fare integration is fairly common and reasonably well understood, while the second is not nearly as common. The following sections will provide a background to both types, as well as describing the fare medium tools that are available for fare integration.

2.2.1 Overview of Fare Integration

There are two major approaches to fare integration: technological, involving the standardization of media used (and consequently, the equipment used by the agency or agencies), and pricing, involving the development of a standard pricing systems among modes and operators. Both types of fare integration have their own obstacles, and can be pursued almost independently (although it is difficult to eliminate all of the linkages). In addition to this major division, there is also the difference mentioned above between intra-operator and inter-operator fare integration, each, again, with its own set of obstacles. The following sections provide a brief qualitative description of the two types of fare integration (intra- and inter-operator) along with a discussion of each of the two approaches to fare integration (technology and policy). Before beginning this in-depth discussion, it is also important to point out that fare integration is only one of a range of actions that can potentially improve integration between vehicles. Others include physical modifications, improved passenger information, and timetable coordination. Without these supporting actions, even the best-planned fare integration strategies may fail.

2.2.1.1 Intra-Operator Fare Integration

Inter-operator fare integration involves the coordination of fare and technology between vehicles operated by a single public transit agency, whether they are of the same or different mode. This type of fare integration is fairly common, particularly for intramodal transfers. Although a transit agency would ideally provide a one-seat ride for all users, operational and efficiency concerns usually dictate some level of transferring. Although the transit agency should not, as some have written, encourage transferring *per se* (since it is not strictly a positive action), the agency should do what it can to ease the transferring process when it is necessary. Particularly in systems that have developed a network structure that relies on transferring (such as grid, transit center, or pulse networks), it is imperative that the agency not further penalize transferring riders by charging them twice for their trip [11].

Policy Integration

For a single operator to integrate fare policy basically involves ensuring that passengers do not have to pay full fare each time they board a new vehicle. To develop this type of fare integration policy, there are a number of different questions that must be considered:

- **Medium** - What medium will be used? The only important distinction is between media where the user pays a separate fare for each ride (such as cash, ticket, token, or stored-value card), and unlimited use media (such as passes) [12]. This will determine the structure of the pricing integration that can be implemented.
- **Mode** - Is the transfer to the same or a different mode? Some agencies have different policies for intramodal fare integration and intermodal fare integration. In the case of unlimited use passes, fare integration within a single mode is an integral part of the pass itself.
- **Transfer Charge** - Will a transferring passenger be charged an extra fee when moving between vehicles, or not [11]? This extra fee may be paid either when boarding the original vehicle or when transferring to the new vehicle.
- **Limitations** - Are there any temporal or geographic limitations on the fare integration policy? This can take the form of transfer discounts that are valid only for a certain length of time, passes that have only limited times of validity, and transfer discounts that are only valid on certain connecting routes [11].

Technology Integration

Integration of technology is considerably simpler, and arises only in the case of integration between different modes (presumably, vehicles of the same mode will have the same fare technology in place). It involves the fairly straightforward process of ensuring that all of the different modes operated by an agency accept the same fare media, whether this means using the same fareboxes, tokens, or stored value cards. This type of

fare integration is fairly common, because most agencies have realized that standardizing their technology benefits both the agency and its customers.

2.2.1.2 Inter-Operator Fare Integration

Turning to fare integration between operators, the issues and obstacles become considerably more complicated, because of the need for cooperation and joint decision-making. In addition to considering the operational choices already described for intra-operator fare integration, there are a variety of institutional and regulatory issues that must be considered. In almost all cases of fare integration between operators, revenue that "belongs" to one operator will be collected by another. For example, if a rider purchases a transfer from one operator in order to transfer to a vehicle operated by a different operator, then the second operator is owed some of the revenue collected by the first. This creates a need for revenue allocation and distribution between the two operators, which can become a source of controversy in any inter-operator fare integration agreement [13,14]. A clearinghouse function must be created to handle all of these revenue allocation transactions.

Policy Integration

The integration of pricing between different operators is a very difficult issue, because it requires each operator to give up some control over fare policy [10]. Because of the direct impact of fare policy on revenue, this is not an area where transit agencies are eager to lose their autonomy. Pricing integration will take much the same form as described in the intra-operator case, but with the added complication of needing to coordinate among different operators, who may have different interests and goals. The most controversial issue in this area is clearly revenue allocation, since riders will be paying less than they would if there were no pricing integration. Depending on the elasticity of demand with respect to price, these price decreases can lead to either increases or decreases in revenue. However, revenue loss is the most common outcome, which often creates a serious obstacle to pricing integration. There is really no general solution to this problem, and developing an acceptable response to revenue loss is a matter of negotiation between the agencies and operators involved. One important issue

is determining the basis for allocating revenue to different operators. Rinks [13] has identified a number of aggregate variables that can be used for revenue allocation, either separately or in some combination. None of these variables provides a failsafe solution to the problem of dividing revenue loss among operators, but they do provide a starting point for developing an allocation procedure.

- **Cost** - Allocation of revenue based on the cost of providing service. However, this reduces the incentive for the agency to reduce costs.
- **Ridership** - Allocation based on the total ridership of each agency involved in the agreement. It is unclear what measure of ridership should be used.
- **Profit / Loss** - Allocation to ensure that the profit or loss situation of each agency does not change after they enter into a fare integration agreement.
- **Subsidies** - Allocation to ensure that the need for subsidy of each agency does not increase after they enter into an integration agreement.
- **Ease of Administration** - Allocation in a manner that is relatively easy to administer (as far as can be predicted based on the data available), particularly in cases where the revenue to be allocated is small.
- **Political Considerations** - Allocation that takes into account the interaction between the transit agencies and the political environment. This can be difficult and can sometimes yield unacceptable results, but it does explicitly consider the realities of the political process.

Recent developments in fare technology allow for improved collection of system information, making the revenue allocation process more accurate. However, it still is likely to be difficult to obtain agreement on a revenue allocation methodology. It is often necessary for a single agency (such as the MPO or the dominant transit provider) to take control of the process and secure funding for initial implementation. In addition to working together on fare integration, it may be necessary for agencies to coordinate in the areas of route design, physical facilities, and timetable development in order to fully realize the potential efficiency benefits of fare integration [15].

In its simplest form, pricing integration can be implemented on only a few routes where it makes the most sense, under some relatively simple revenue allocation method [12]. This type of simple through-ticketing can be useful in situations where operators do not have services that overlap greatly, but rather only a few interchange points. At the other extreme are systems with extensive service overlap (and concomitantly high need for transferring). In this case, it is necessary to work out a more complicated agreement that allows more extensive integration [12]. In addition, in this situation integration can have significant effects on revenue (both positive and negative), which will further complicate the development process [11]. It is important for agencies to analyze their operations closely and then decide the level of integration (if any) that is appropriate for their situation, keeping in mind the increasing time, effort, and money that will be required for different levels of integration.

Technology Integration

As with intra-operator fare integration, the integration of technology between different operators is somewhat less complicated than pricing integration. However, it is still quite difficult, because of the need to purchase new technology and/or modify existing technology in order to reach a point where compatible technology is in use by all participating agencies. In addition, once all agencies have agreed to a technology, they will be stuck with that technology (and likely a single manufacturer), meaning that they are all locked into the same procurement cycle.

To implement technological integration, the agencies must look at the different fare technologies that they are currently using, and decide on a path that will allow them to achieve some sort of standardization. This involves making purchases or modifications to ensure consistent acceptance of the fare medium that will be used, whether this is tickets, tokens, passes, or some kind of stored value card. Depending on the situation of the agencies, it may make more sense to change to a fare medium that can be processed by current fare equipment, or to purchase new equipment that can accept a universal fare medium.

The developments that have taken place in recent years in fare technology can provide a strong boost to the implementation of regional fare integration. Many agencies are in the process of replacing their current fare technology because of the potential for operating and management improvements. This replacement process provides an opportunity for agencies to work together to procure technology that will make it easier to implement a regional fare integration system.

2.2.2 Fare Integration Media

From the set of all the fare media that can be used in a fare system, there are basically two that are amenable for implementing fare integration: transfer discount mechanisms, which are used for all single-ride payment media, and unlimited-use passes, which are in themselves fare integration tools. This section provides a brief description of these, along with some of the important issues that must be taken into account for each.

2.2.2.1 Transfer Discount Mechanisms

For passengers who are paying using a single-ride payment medium, such as cash, a ticket or token, or a stored value card, fare integration generally involves providing some sort of transfer discount mechanism to passengers [11]. In most cases, this means issuing what is commonly referred to simply as a "transfer," generally a piece of paper or card bearing visual or magnetic information about the conditions and validity of the transfer discount. As discussed earlier, this transfer can be free, or sold at some cost that is lower than the full fare of the subsequent modes used. The transfer will be manually or automatically verified once the passenger wishes to access the second mode. In the case of stored value cards, it is not strictly necessary to issue a separate transfer, since the necessary validity information can be stored on the card itself [16].

There are a number of issues that must be considered when looking at transfer discount mechanisms [11,13]:

- **Cost**
- **Revenue Allocation**

- **Validity**
- **Medium**
- **Acceptance**

2.2.2.2 Unlimited-Use Passes

An unlimited-use pass in itself constitutes a fare integration tool, since it can be accepted on a wide variety of different vehicles, regardless of mode and operator. Particularly with passes that are verified visually, it can be quite simple to begin accepting one operator's pass on another operator's vehicles (although revenue allocation remains a significant obstacle). A variation on this is the pass sticker, where one operator's pass becomes valid for travel on another operator when a special sticker is affixed [16].

Unlimited-use passes have many of the same issues as transfer discounts [13]:

- **Cost**
- **Revenue Allocation**
- **Validity**
- **Flexibility**
- **Medium**
- **Acceptance**
- **Distribution**

2.3 Conclusion

This chapter has provided an overview of the important issues that are involved in the development of a public transit fare system, along with coverage of some of the specific issues in fare integration. The hope has been to provide the reader with the information and knowledge needed to get the most from subsequent chapters. For the reader who is interested in exploring this issue in greater depth, the *TCRP Report 10*, as well as the other references cited in this chapter, should provide a good starting point.

3. Case Studies

Many public transportation agencies throughout the world have implemented fare integration strategies in order to realize the benefits mentioned in earlier chapters. The many innovative and interesting fare integration strategies that have resulted provide a base of experience for others to build upon. For the purposes of this research, eight cases have been studied to determine what fare integration strategies have been implemented and which have been successful. Case studies were chosen for two major reasons: the presence of particularly interesting fare integration strategies and commonality of at least some characteristics with San Juan. The following systems / cities were chosen for consideration based on one or both of these characteristics:

- **New York City Transit** - New York City Transit has recently introduced the Metrocard magnetic stored-value card, which will provide a flexible medium for implementing new fare integration strategies. In addition to the transfers that currently exist between commuter rail and certain bus lines, NYCT is also in the process of implementing a combined commuter rail pass and Metrocard fare instrument, and is moving towards testing free transfers between bus and rail.

- **Washington Metropolitan Area Transit Authority** - WMATA, which has been using a magnetic stored-value card system since its inception, has a number of fare integration strategies in place, both within its own system and with other rail and bus systems in the Washington, DC, area. WMATA is also testing the implementation of smart card technologies that would allow greater fare integration flexibility.

- **Société de Transport de la Communauté Urbaine de Montréal (Montreal Urban Community Transport Corporation)** - The STCUM has focused on fare integration for many years, both within its own services and with other transit agencies in the metropolitan area. Strategies in place include free transfers within the system, free transfers to and from the commuter rail system, and a regional pass in coordination with the other two major public transit agencies in the area.

In addition, the recently created Agence Métropolitaine de Transport (Metropolitan Transportation Agency) is studying the possibilities of a regional smart card system, which would create a new medium for fare integration.

- **Metropolitan Transit Development Board (San Diego)** - Since the early 1980s, the MTDB has had a Uniform Fare Structure Agreement (UFSA) in place, which provides for fare integration between the various fixed-route and dial-a-ride transit operators in the San Diego area. The system is based mainly on the use of free transfers for movement between "equal" modes, with upgrades required when a passenger transfers up from a "lower" vehicle to a "higher" vehicle. This system, which does not require the use of high technology and incorporates a number of small, private operators, may provide a useful example for the San Juan area.

- **South Coast Area Transit (Oxnard, CA)** - SCAT currently participates in a multi-operator smart card system with six other operators in Ventura County, CA. Known as Passport, the system consists of a smart card that is valid for payment on all seven operators, providing a medium for seamless fare integration. Although the system has experienced some problems in its initial implementation, it is a very instructive example of multi-operator fare integration using a technology solution.

- **San Francisco** - In the past fifteen years, numerious operators in the San Francisco Bay Area have been involved in various attempts at fare integration. In the early 1980s, the major fare integration effort was the sale of stickers by one system, which could then be attached to the flash pass of another system, giving the bearer unlimited rides on both systems. More recently, fare integration attempts have been made using the stored-value cards pioneered by BART, both as flash passes and as stored-value cards on buses. The Metropolitan Transportation Commission in Oakland is currently studying the implementation of a uniform smart card fare medium, which could be used on all Bay Area public transit systems. The experience of San Francisco with a relatively large number of

distinct operators could provide some guidance in dealing with the different operators in the San Juan area.

- **London Transport** - Over the past fifteen years, London Transport has been one of the leaders in fare integration, particularly in the area of unlimited use passes. Since 1980, LT has been restructuring its fare system, with the general aim of fare simplification and fare coordination (goals which can often conflict). The introduction of Travelcards in the early 1980s has probably been the most significant fare integration strategy, particularly with the extension to include British Rail suburban services in 1989. More recently, extensive private sector involvement in service provision has presented a new challenge, particularly the need to allocate Travelcard revenue among different private operators. Given this extensive, well-studied experience with fare integration and the involvement of the private sector, London Transport may provide some useful insight into the potential strategies for the San Juan area.

- **Santiago Metro (Santiago, Chile)** - Public transportation in Santiago is provided by two major modes: Metro S.A., which operates a two-line, publicly owned subway system (as well as some connecting bus service), and a large number of private bus operators. This situation bears some similarity to what will exist in San Juan, with the interaction between Tren Urbano and the numerous público drivers. Given this system similarity (as well as some of the cultural similarities), Santiago's system may provide some interesting lessons for San Juan.

The information presented in the following case studies is based mainly on information from a survey that was sent out to a representative of each agency, as well as subsequent interviews with those agencies. A copy of the survey instrument used is included as an appendix following the final chapter. Information obtained in that way is not specifically referenced, but other sources are indicated wherever necessary.

3.1 New York City

New York City Transit (NYCT) is a unit of the New York Metropolitan Transportation Authority (NYMTA), the regional transportation organization that is

responsible for public transportation in the New York City area. NYCT provides service in the five boroughs of New York, on both bus and rail. After a recent fare increase, the basic fare is a $1.50 flat fare, payable in cash, token, or stored-value card (known as the Metrocard). In addition to New York City Transit, NYMTA also oversees two of the three commuter railroads in the New York area, Metro-North Commuter Railroad and the Long Island Railroad (New Jersey Transit operates the third commuter rail system). NYMTA is also responsible for smaller bus systems in the outlying areas, rapid transit in the borough of Staten Island, and a number of bridges and tunnels through its control of the Triboro Bridge and Tunnel Authority [17].

3.1.1 Current Fare Integration

Traditionally, New York City has not been particularly interesting in terms of fare integration, because there has been relatively little activity. Although New York City's major transit agencies are under the control of NYMTA, this has not led to a great deal of integration. Looking first at the basic subway and bus system, the major form of fare integration is the fact that both modes accept the same token (and the new Metrocard, which will be discussed at greater length later). In addition, transfers are available between certain bus routes (restrictions are in place mainly to ensure that passengers do not make stopovers or round trips) as well as between subways at physical intersections (although these are sometimes constrained by physical limitations). In addition, some free transfers are available between the Staten Island Railway and NYCT buses that operate on Staten Island and in Manhattan [17]. All of these services are provided by NYCT, and no major effort is made to track transferring patterns or to allocate revenue (at least on paper) between the operating divisions.

The MTA's commuter railroads, the Long Island Railroad (LIRR) and Metro-North Commuter Railroad (MNCR), also have some fare integration in place using combination passes. These passes, known as Unitickets, are weekly or monthly commuter rail passes that provide free or discounted travel on commuter bus services that connect to rail stations. These connections are available both at the outer, suburban end of the trip and at the stations within New York City for access to final destinations.

Unitickets are priced higher than the corresponding regular commutation ticket, but provide a discount over the independent costs of the two services. In addition, some other discounted transfers are available between commuter rail and connecting suburban bus services, but these do not represent a significant part of fare integration in New York City [17]. Looking specifically at connections to New York City Transit, LIRR Unitickets are accepted on certain buses in Queens, while MNCR Uniticket holders are given a discount on the express bus fare between Grand Central Terminal and Wall Street [17]. Because the bus services that accept the Uniticket are separate MTA operating entities (and some are not part of the MTA), there is a need for revenue allocation between operators, based on information collected about ridership patterns. Because the commuter railroads collect the entire price of the Uniticket, they must reimburse the bus companies for the cost of providing this service. In the case of NYCT, this usually means that the commuter railroads pay about 50% of the cost of the Uniticket passengers.' At this point, the Uniticket does not provide any transfer privileges to the subway system, which limits its success at the New York City end of the trip.

3.1.2 Future Plans

Overall, New York City has made some efforts at fare integration, but these have been fairly spotty, and have not addressed the major question of fare integration with the subway (beyond physical connections). However, the introduction of the Metrocard stored-value card has the potential to significantly change this, and present plans will result in greater fare integration in terms of both media and pricing. The Metrocard is a stored-value card that will soon be accepted on all bus and subway lines that are operated by New York City Transit. Currently, Metrocard reading equipment is installed on all New York City buses, while subway stations are still currently being refitted (that process is expected to be complete by July 1997). Once installation is complete, the Metrocard will be used for all current transfer arrangements, including the current system of transfers between buses. In addition, the implementation of the Metrocard will allow for a number of new fare integration strategies in the future. Most importantly, NYCT is currently planning to implement free transfers between the subway and bus systems, valid for a two hour period. The implementation of this strategy has been fairly controversial, both

inside and outside the agency, particularly because of the revenue loss that is likely to accompany it. Unfortunately, it is difficult to obtain information about the status of free transfers, both because of the sensitivity of this issue and because many of the important decisions are being worked out at this writing. Testing of the free transfer system is scheduled to begin on July 4th, 1997.

In addition to the implementation of free transfers between bus and subway, the Metrocard is also expected to allow greater fare integration between New York City Transit and the commuter rail system. This increased fare integration is proceeding in two stages, the first dealing with fare medium integration and the second dealing with fare pricing integration. Starting in the very near future (the exact implementation date is unclear), Long Island Railroad riders who purchase a monthly pass by mail will have the option of purchasing a card with a monthly commuter rail pass on one side and a Metrocard on the other side. The Metrocard will arrive encoded with $0, $30, or $60, allowing the user to customize it to their level of subway and bus usage. Starting in 1998, this program will be extended to provide a 9.1% discount on the price of both the pass and the Metrocard (only available to those ordering passes by mail). It will be very interesting to see the impacts of these two actions, because it will provide some insight into the relative importance of increasing convenience versus reducing costs. Again, these proposals have been somewhat controversial, which has made it difficult to obtain information about the process itself.

3.1.3 Conclusion

Both of these new proposals are in the study or early implementation stage, so it is not possible to draw conclusions based on any outcomes (and the political sensitivity mentioned earlier makes it difficult to obtain any information about any *a priori* analysis). Nonetheless, the simple fact that NYCT is moving towards greater fare integration is an encouraging sign, as is the public support that has resulted, particularly for free transfers between subway and bus. Given the size and complexity of the New York City transit system, the future outcome of their efforts at fare integration should be quite instructive for other locations that are considering implementing some form of integration.

3.2 Washington, DC

The Washington Metropolitan Area Transit Authority (WMATA), in Washington, DC, operates both rapid transit (Metrorail) and bus (Metrorail) service, and interfaces with the two regional commuter rail operators as well as a number of local bus operators. The fare system for both Metrorail and Metrobus is based on distance traveled, with the rail using a very finely graded scale and the buses using a coarser zone system [18]. WMATA was one of the first US systems to implement a stored-value fare system on its rail system, which has been in place since its opening in 1976 [19]. The bus system does not currently use a stored-value card, relying instead on a system of cash, tickets, tokens, and paper transfers [18,19]. WMATA is in the process of implementing a contactless smart card stored-value card, which will eventually be used on all modes. This smart card is currently being tested in a number of locations, including as a means of payment at park-and-ride lots [20].

3.2.1 Current Fare Integration

WMATA has a number of fare integration strategies in place, both among its own services and with other public transit providers in the area. Within its own services, WMATA relies mainly on a system of paper transfers and passes. For the heavy rail system, the system is similar to most subway systems, with transfers available at physical interchanges (although the value of this is somewhat reduced because of the distance-based fares). On the bus system, transfers are available between buses for 10¢, with a new transfer required for each additional connection. Between modes, transfers are available for persons moving from rail to bus, but—for logistical and political reasons—not in the other direction [18]. These transfers, which are available free when boarding the rail system, entitle the holder to some discount on the fare when they board a Metrobus. The amount of the discount is based on the time of day (peak vs. off-peak) and the jurisdiction where the transfer is being made (the discount varies from 85¢ in the District of Columbia to zero for services in Maryland) [18]. These differences arise due to the differences in funding arrangements amongst the different jurisdictions that pay for service. No revenue allocation is made between the bus and rail system based on these

transfers, with the bus system absorbing the lost revenue. Although this system of transfer discounts does provide a means for reducing the cost of moving between vehicles, it is rather complicated, both for the passenger who must be aware of the different restrictions, and for the bus operator who must ensure proper payment. This is likely to discourage use of these fare integration strategies, particularly amongst riders who are unfamiliar with the system (this is a particular concern given the number of tourists who visit Washington).

In addition to these one-time rider fare integration strategies, WMATA also offers a number of unlimited use pass options that are valid on Metrorail, Metrobus, or both. Perhaps the most flexible of these options is the Bus/Rail SUPER Pass, which for $65 (in late 1996) allows the rider unlimited ridership on both Metrobus and Metrorail for a period of two weeks [18]. Although this may seem expensive, it is not unreasonable given the area covered by Metrobus and Metrorail and the base fare that is charged. WMATA also offers a $25 Arlington County Flash Pass, which allows unlimited bus rides within Arlington County, and provides a $15 stored value for use on the rail system. In addition to these intermodal passes, unlimited use passes are also available separately for use on the bus and rail systems. The passes on the rail system are fairly straightforward, including a 1-day unlimited pass (valid after 9:30 am), a 14-day short ride pass (valid for unlimited use on trips that cost less than $1.60), a 14-day unlimited use pass, and a 28-day unlimited use pass. The bus system passes are more complicated, with different two week passes available for travel in different areas [18]. This system of flash passes is considerably less complicated than the transfer discount system, although the number of different options available for various bus zones is still difficult to grasp. This system is also quite complicated from the perspective of bus operators, requiring them to differentiate between a number of passes, with different restrictions in place during the peak and off-peak. This is made even more complicated by the fact that the driver is also expected to ensure that riders are only traveling the distance that their fare allows them, even though they are only verified on boarding.

As far as inter-operator fare integration is concerned, WMATA also has a number of somewhat *ad hoc* fare integration strategies in place with other public transit operators

in the region. In addition to the Metrobus system that is directly operated by WMATA, certain jurisdictions in Virginia and Maryland have started their own bus systems as a supplement, such as Ride-On, Dash, and Fairfax Connector. WMATA maintains fare integration agreements with many of these systems, at locations where they interface with the Metrobus and Metrorail system. The agreement with Ride-On is the most extensive, and includes a joint all-day pass as well as bus and rail transfers. Four other systems, Dash, Fairfax Connector, CUE, and The Bus, maintain a system of rail and bus transfers to WMATA's system. As with transfers between Metrorail and Metrobus, transfers mainly take place from WMATA to the other operators, not in the other direction. No attempt is made to transfer money from WMATA to these other operators, because the jurisdictions that fund these supplementary bus services are also funding WMATA, based on the service provided. If WMATA were to allocate money to the other operators on the basis of the number of transfers made, this would simply be a transfer back to the original funding source, so it has not been deemed necessary to implement any revenue allocation process.

In addition to the suburban bus operators, Washington is served by two commuter railroads, Maryland Rail Commuter (MARC) and Virginia Railway Express (VRE). WMATA maintains fare integration agreements with both of these railroads, in the form of monthly passes that are also good for unlimited travel on Metrorail. These agreements are fairly straightforward, with WMATA simply selling the unlimited use cards directly to the railroads, who then print their monthly pass information on the other side and sell them to their customers. It is up to the railroad to decide what to charge for the combined pass, with VRE offering a discount and MARC selling it at their purchase cost from WMATA. These are fairly easily administered fare integration strategies, and relieve all operators of the need to decide on joint revenue allocation or subsidy agreements. In addition to these agreements with WMATA, the commuter railroads also maintain their own fare integration agreements with other operators, including the rail and bus system in Baltimore.

3.2.2 *Future Plans*

As mentioned above, WMATA is also assessing the use of smart cards in the form of the Metro GO Card, which is currently under testing in a variety of different applications throughout the system. Eventually, the GO Card (or its descendant) is intended to replace the existing system for fare payment of rail and bus, as well as the manual collection of parking charges at park and ride lots [20]. This will provide fare integration in terms of media, and opens the opportunity for maintaining the current fare integration strategies, or perhaps expanding on them. The GO Card may also provide a means for simplifying some of the more complicated elements of the current fare integration policy, or at least making them easier for passengers and drivers to deal with. It could also give WMATA the flexibility to implement innovative new fare policies, and to coordinate fare media with other transit providers in the region.

One interesting aspect of the GO Card is the attempt to implement zonal fares using verification on both entry and exit. Under this system, when a rider boards a bus, the maximum possible fare is nominally debited from the card (although no money is actually debited). When the rider gets off, the reader calculates the real fare that is to be charged and deducts only that amount. If the rider does not have the card read when disembarking, the maximum value will eventually be deducted (either after some time limit, or the next time the rider boards a vehicle with the card). Although there are a number of customer related issues that arise with this strategy, it is a fairly innovative approach to the process of automating the verification of distance-based fares on buses. The Go Card trial involved 1500 participants, 29 Metro entrances, 21 buses, and 5 parking facilities [20]. At this writing, no detailed results of the evaluation were available, but WMATA is in the preliminary stages of implementing the Card system-wide, which would appear to indicate that their experience was successful.

3.2.3 *Conclusion*

WMATA has some interesting fare integration strategies in place, both internally and with other operators. Although the extensive use of one-way rail to bus transfers makes their strategy somewhat complicated and inconvenient, it seems that they are

satisfied with this as a medium-term strategy (at least until they are ready to change over to a smart card system). An interesting aspect of fare integration in Washington is the interplay of the different jurisdictions that fund the service, and the varying degree to which transfer discounts are provided. It is clear from this that there are differing levels of commitment to fare integration by these different political units, leading to this complicated pricing structure. This implies that fare integration is not high on the priority list for either WMATA or its funding sources, which is unfortunate. If WMATA could get all the areas that it serves to agree on a more uniform fare structure, this could lead to a system that is easier for all riders to use. However, it is important to note that many of the obstacles to more complete fare integration result from technology, particularly the incompatibility of the bus and rail fare collection technologies. Hopefully, the introduction of a single fare medium in the form a smart card will help to resolve some of these problems and lead to better fare integration in the future.

3.3 Montréal, Canada

The Societé de Transport de la Communauté Urbaine de Montréal (STCUM) provides service to all communities on the island of Montreal, operating bus, heavy rail, and paratransit service. In addition to the STCUM, there are two other major operators in the metropolitan area: the Societé de Transport de Laval (STL, or Laval Transport Corporation), which operates service in a major community to the north of Montreal, and the Societé de Transport de la Rive-Sud de Montréal (STRSM, or Montreal South Shore Transport Corporation), which operates service in communities to the south of Montreal. There are also a number of small, local transit agencies in the exurban regions not served by the larger operators [21], as well as two commuter rail lines funded by the Agence Métropolitaine de Transport (AMT, or Metropolitan Transport Agency). The STCUM's fare system is fairly straightforward, using a flat fare on all modes other than commuter rail, and is based mainly on the use of deeply discounted multiple use fare instruments. As of January 1st, 1997, the base fare was CAN$1.85, while 12 tickets purchased in a strip cost CAN$16.00, which amounts to CAN$1.33 per ticket, a 28% discount from the base fare. Similarly, the adult monthly pass is priced at CAN$45, approximately equivalent to

24 individual, full-fare trips, or only 12 round trips per month, making the pass attractive even to irregular riders [22,23].

3.3.1 Current Fare Integration

The STCUM's fare policy is coordinated between all service it operates, and is consistent for almost all types of transfers, with some restrictions to prevent blatant abuse of the system. The payment of an individual fare entitles the rider to unlimited transfers for 1½ hours following boarding. Until recently, riders were explicitly allowed to make stopovers and round trips during the time of validity, but this was canceled as of the recent fare increase [24]. The only major restriction now is that riders who obtain a transfer after boarding the subway cannot use that transfer to re-enter the subway system. These transfers are also valid for travel on the inner portions of the commuter rail system (passengers can also pay an upgrade fare for travel to more distant stations). In addition, the STCUM offers monthly passes that are valid for unlimited travel on bus, subway, and the inner portions of the commuter rail systems (more expensive passes are available for the outer commuter rail zones, and these are also valid for unlimited travel on the subway and bus systems) [22]. For STCUM riders, this provides a high degree of fare integration, giving almost all travelers the opportunity to make their trip on one fare, using fairly simple fare media.

The larger regional transportation system (including the two other major operators in the region) also has some limited integration, in the form of a regional flash pass that is valid for unlimited travel on all three operators. This regional pass was originally implemented through a regional public transportation agency, the Conseil Métropolitain de Transport en Commun (Metropolitan Council on Public Transportation). This council, which had relatively little power or responsibility, was recently replaced by the more powerful AMT, which has the mandate of improving regional passenger transportation in the Montreal metropolitan area. This agency hopes to move towards greater regional integration in the future, particularly with the goal of improving public transportation service using the infrastructure that is currently in place [25].

The existence of this integration between services of different operators creates a need to allocate the money that is collected from this pass. When the regional pass was first introduced in the early 1990s, revenue allocation was based on information about the residence location of the people purchasing the cards. This information was collected in onboard surveys of users of the pass, and the revenue was then divided up based on this geographical distribution. More recently, this methodology was changed so that the allocation is based on the number of revenue passenger kilometers that these pass holders travel on each of the systems (again determined by passenger surveys), which is more directly related to the cost of the service and the benefits being provided by each operator. Although the STCUM uses magnetically encoded passes for entry into the subway system, the bus fareboxes are not currently equipped to handle magnetic fare media, so this information cannot be used for revenue allocation purposes. In terms of fare integration within its own services, the STCUM is beginning to analyze revenue allocation between its bus and subway systems (mainly as a paper exercise), to provide improved planning and management information.

3.3.2 Future Plans

Like almost all public transit agencies, the STCUM is currently studying the possibility of introducing smart cards, particularly for its regular customers. This initiative has two major goals: increasing the flexibility of the STCUM's fare system, and improving the quality of data for management and planning purposes [26]. In addition, the STCUM's current fare system is in major need of overhaul: although the system in use on the subway is reasonably sophisticated, the bus system still uses manual fareboxes that do not even have the ability to count the revenue deposited. To resolve this situation, the STCUM has made the preliminary decision to move towards a new fare collection system based on the joint use of smart cards and magnetic stripe cards. Regular users of the system will have their monthly pass or bulk purchase of tickets encoded on their smart card at the time of purchase. Occasional users of the system will be able to buy magnetic stripe cards (with an expiration date), which will be encoded with smaller values [26]. Subway users will be required to purchase a stored-value card (as is the case on many systems that use magnetic stripes), while bus riders will still be able to pay their fare in

exact change, in addition to being able to use a stored-value card. Currently, no automatic vending equipment is used by the STCUM (except on a recently renovated commuter rail line), but the new fare collection system would be based heavily on the use of automated vending, particularly at subway stations [26].

In the short term, the STCUM plans to retain its current fare structure after the new technology is installed. However, one of its key objectives in the procurement of new technology is to provide the flexibility to implement a wide variety of different fare strategies and structures (potentially including new fare integration strategies). Although no changes have yet been defined, the STCUM wants to ensure that current decisions about technology (which must be made relatively quickly) do not constrain future decisions about policy [26]. As mentioned earlier, the other major objective of the new fare system is to provide the best possible management and planning data. Because of the computing power that will be involved, both on the smart card itself and in the collection equipment, a variety of passenger data can be collected, including origin location, transfer location, and a variety of time-based demand information. As compared to the current data collection situation, the STCUM should be able to make vast improvements in the quantity and quality of the data produced by the fare system [26].

3.3.3 Conclusion

The STCUM provides an example of an agency that has pursued fare integration with sustained commitment. Their overall fare integration strategy is reasonably easy to understand, particularly since it is consistent across all modes. With the introduction of a regional pass, and the recent creation of the AMT, the STCUM and the other public transit operators have taken concrete steps towards continued integration. This inter-operator fare integration will likely continue in the future, because the AMT is working to ensure that all three major operators (STCUM, STL, and STRSM) standardize on a common fare technology. This continued fare integration will create a more seamless transportation system for the users, and help to ensure the continued success of public transit in the Montreal area.

3.4 San Diego, CA

The Metropolitan Transit Development Board (MTDB) in San Diego, California, was created in 1975, with responsibility for transit planning, funding, and coordination in the San Diego metropolitan area. MTDB also oversees the Metropolitan Transit System (MTS), which consists of a variety of light-rail, fixed-route, and demand responsive transit services operated by fourteen different service providers, including San Diego Transit and San Diego Trolley [27]. In addition, service is also provided by the North County Transit District, which operates separately from the MTS (with some coordination). The MTS fare system is quite complicated, due to the range of rail, local, urban, express, demand responsive, and paratransit service operated, as well as the variety of fare media available. The adult base fare ranges from $1.00 up to more than $3.00, depending on the type of service [28].

3.4.1 Current Fare Integration

In its service coordination role, MTDB undertakes to ensure some level of fare integration between the different services (as well as trying to create coordination in other ways). Over time, this effort has led to the creation of a fairly comprehensive fare integration system, which allows riders to transfer easily between different services, even those that offer a different type of service or are operated by different entities. The mechanism by which this has been accomplished is the Uniform Fare Structure Agreement (UFSA), which provides a framework for fare integration between different operators. It is worth noting that this fare integration system does not depend on the use of high technology, but rather on flash passes, tickets, tokens, and manually issued transfers. As mentioned above, the MTS fare collection system is fairly complex, but the UFSA provides the structure needed to ensure that the fare integration strategies are reasonably consistent throughout the system.

The UFSA sets out the overall structure of fare integration, according to the following sections [29]:

- **Purpose and Responsibility**

- **Definitions**
- **Base Cash Fares**
- **Regional Transfers**
- **Passes and Tickets**
- **Regional Monthly Pass Upgrades**
- **Regional Ticket and Pass Administration**

In addition to these main sections, attachments to the UFSA detail supplemental information, including prices of different fare media, formulas for revenue allocation, and the different fare zones.

From the perspective of fare integration, sections four, six, and seven of the UFSA, which detail the different fare integration strategies, are the most interesting. Section four describes the structure of transfer-based fare integration, based on the concept of a hierarchy of modes. This hierarchy includes the traditional bus (local, urban, and express) and light rail modes, as well as dial-a-ride and ADA paratransit services. The hierarchy is based mainly on the fare for each mode, although there are some subtleties involved. Transferring between two "equal" modes, or from a "higher" to a "lower" mode, is free, while transferring from a "lower" to a "higher" mode requires the payment of an upgrade (in increments of 25¢) that is roughly equal to the difference in fare between the two modes. This system applies to all modes in the Metropolitan Transit System, as well as when transferring between the MTS and NCTD services (NCTD also has its own internal fare integration strategies, which are not included in the UFSA). In addition, this section details the physical appearance of the transfer slips that are issued and the information that must appear on them. Also included is information about the time of validity of the transfers, and any directional restrictions that exist.

Section six provides the same information for transferring involving unlimited use passes. The passes themselves are described in section five, which sets out the price and validity of the different regional passes that are sold. Intrinsically, these passes are fare integration instruments, since they provide a free transfer between the modes that accept a

particular pass. Section six expands this, by detailing the process for upgrading a pass for use on a "higher" mode. As with the transfer slips, riders can use a pass of a certain value on any mode that accepts that pass, as well as any "lower" mode, and can pay an upgrade charge (in 25¢ increments) to transfer to a "higher" mode with a pass from a "lower" mode. This information is detailed for both regular fare passes and student and senior/disabled passes.

Section seven covers the administration of the UFSA, for both regulators and operators. The San Diego Association of Governments (SANDAG) is responsible for gathering transfer and pass usage information from all operators and determining how revenue should be allocated (based on revenue allocation formulas that are detailed in the attachments). SANDAG then provides this information to MTDB, which is responsible for further compiling it and then reimbursing all operators on a monthly basis. MTDB also has responsibility for designing and distributing regional fare media, as well as funding any expenses related to distribution and reconciliation of these prepaid fare media. MTDB and SANDAG together produce informational reports that detail pass usage, for use in planning and management by the individual operators. The individual operators are responsible for keeping track of pass and transfer usage, and submitting those counts for use in the revenue allocation process. The revenue allocation is based mainly on these driver boarding counts, which are input into the formulae used to calculate how revenue is distributed. This revenue allocation process can be modified each time the agreement is renewed, but the procedures are fixed for the duration of the current UFSA.

3.4.2 Conclusion

The UFSA is a very interesting document, because it sets out in detail how each operator must behave and what actions they must take to ensure the continued success of the system. The UFSA has been in existence since the early 1980s, and has been refined and modified over time to take into account experience and results. As such, it represents a highly developed fare integration strategy, which has managed to survive changes over time. San Diego appears to be one of very few agencies that have such a highly

developed inter-operator fare integration agreement, at least in the United States. However, this type of agreement is extremely important to the success of inter-operator fare integration. Although much can be done with technology, even a very technologically sophisticated system (which San Diego's currently is not) will need an agreement of this type if fare integration is to have any significant effect on travel behavior. The San Diego Uniform Fare Structure Agreement provides the framework for this, and provides a useful reference point for other transit agencies that are looking to implement inter-modal, inter-operator fare integration.

3.5 Oxnard, CA

South Coast Area Transit (SCAT) is a small, bus-only transit agency located in Oxnard, CA, outside of Los Angeles. Operating only 37 buses, it provides service to a largely suburban area, and intersects with a number of other transit agencies in the area (including Metrolink commuter rail). SCAT operates fourteen routes, mainly in the cities of Oxnard and Ventura [30]. SCAT has a fairly straightforward fare system, with a current (1996) base fare of $1 and discounts for students, seniors, and disabled riders. Transfers are provided free of charge and are valid on other buses (of a different number) traveling in the same general direction. In addition, riders from Metrolink can use their Metrolink ticket as a free transfer to board SCAT buses (this arrangement with Metrolink is common for services that feed rail stations). SCAT also offers two discounted multiple ride instruments: multiple ride tickets are available in 10, 20, and 30 ride packages, at a savings ranging from 25% to 33% of the base fare, while monthly passes offer a discount of 30% (off the base fare) [31].

3.5.1 Current Fare Integration

With this fairly simple system, SCAT does not really represent a significant fare integration challenge. However, a number of other operators provide service in the Ventura County area, and fare integration with these other operators has become an important issue in recent years. Three years ago, the Ventura County Transportation Commission (VCTC), which is responsible for transportation planning in Ventura County, began operating the Ventura Intercity System Transit Authority (VISTA), which

provides intercity service throughout the county [32]. Along with the introduction of this service, VCTC introduced a regional flash pass, called the Passport, which is valid on all seven bus services that operate in the county. At the same time this was taking place, the California Department of Transportation (Caltrans) was becoming interested in demonstrating smart card technology, and came up with the idea of using the Passport as a test bed for this new technology, leading to the creation of the Smart Passport.

The Smart Passport, which eventually replaced the original Passport, was designed and implemented by Caltrans, with varying degrees of support from the seven transit agencies that are involved (SCAT, plus Camarillo Area Transit, Moorpark City Transit, Ojai Trolley, Simi Valley Transit, Thousand Oaks Transit, and VISTA) [33,34]. The Passport is a radio frequency contactless smart card, which is read at close distance by readers mounted next to the fareboxes. The Passport can be used in two ways: as an unlimited use pass (like the original Passport) or as a debit card. When used as a debit card, the Passport must be credited in $10 increments, but $11 of credit is added for each $10 payment that is made, giving a discount similar to what is available with multiple-ride tickets. At the time of boarding, the appropriate fare for each system is automatically deducted, and the remaining value on the card is displayed. As an unlimited use card, the monthly Passport charge is currently $40 for adults, $30 for students, and $20 for seniors and disabled (prices that are close enough to those for the regular SCAT passes to make the pass very attractive to anyone who needs to transfer between systems) [34].

The Smart Passport provides fare integration principally with respect to technology, with the major benefit being that riders transferring between systems do not have to worry about the different tickets and tokens that are in use, or about having exact change available for each bus they board. Used as a pass, the Smart Passport does not provide much of an advantage over the original Passport, although it does provide vastly improved data collection [33], which can be used for revenue allocation as well as a host of other planning and design activities.

3.5.2 Conclusions

Overall, this smart card demonstration in Ventura County provides useful information about the advantages and disadvantages of smart cards. Although the implementation has gone relatively smoothly, there have been problems with acceptance, both by agencies and by individual drivers. Customers, however, seem to have accepted the card without any major problems, and no privacy concerns have arisen (this is an issue that has worried many with respect to implementing smart cards). SCAT has been able to gather a variety of useful ridership data, demonstrating the superior data collection that is possible with smart cards [33]. The success of the Smart Passport as a fare integration medium is less clear, since little work appears to have been done to evaluate it on that basis. However, it is clear that smart cards will play an important role in the future of fare integration, and the experience with the Smart Passport demonstration provides a view of how this technology is likely to be used in the future. Because some agencies are not completely happy with the current implementation, the future of the Passport is unclear at this point. However, this initial demonstration has proved that smart card implementation is possible on buses, and provides some guidance on how this technology might be used in the future, both as a general fare medium and as a fare integration tool.

3.6 San Francisco, CA

The San Francisco Bay Area has well over thirty transit agencies, making fare integration important but also a difficult challenge. Fortunately, most of these agencies are relatively small, operating service only on a few routes in compact areas [35]. For the purposes of this analysis, only the major operators in the area are considered: Bay Area Rapid Transit (BART), which provides regional rapid transit service; San Francisco Municipal Railway (Muni), which provides bus and light rail service in the City of San Francisco; Alameda-Contra Costa Transit District (AC Transit), which provides service in Oakland and surrounding communities; San Mateo County Transit (SamTrans), which provides service along the peninsula between San Francisco and Palo Alto; and Santa Clara Valley Transit Authority (VTA), which provides service in the area around San Jose [35]. In addition to these major operators, there are a couple of other operators that

are of interest with respect to fare integration: County Connection, which provides service in Walnut Creek and Concord (northeast of San Francisco); Caltrain, which provides commuter rail service between San Francisco and San Jose; and Alameda/Oakland Ferry, which operates between Alameda, Oakland, and downtown San Francisco [35].

All of the agencies have their own fare policies, adding to the complication of fare integration in this area. BART fares are distance based, and range from $1.00 to $4.25, with each origin-destination station pair having a distinct fare. Fares are paid using a stored-value card that must be verified on both entry and exit, with the appropriate value deducted on exit. Cards are available in a variety of denominations, with higher valued cards providing a value bonus over the amount that is paid. BART also operates a system of BART Express services that connect to BART stations, which charge fares on a zonal basis, ranging from 95¢ to $1.50 for adults [35].

Muni services operate on a flat fare of $1.00 ($2.00 for cable cars). Weekly and monthly passes are also available, at $9 and $35 respectively, as well as 1-, 3-, and 7-day visitor passports. Muni issues transfers free of charge upon boarding, and these are valid for up to two hours for two boardings in any direction, except on cable cars [35].

AC Transit also uses flat fares, with different fare structures for local trips in the East Bay versus TransBay trips that serve downtown San Francisco. Cash fare on local trips is $1.25, ten tickets are available for $10, and a monthly pass costs $45. For TransBay trips, cash fare is $2.20, ten tickets cost $18, and a monthly pass is $75. A variety of discounted fare instruments are also available for use by youth (13-17), child (5-12), senior (65+), and disabled riders. Transfers can be purchased at the time of boarding for 25¢, and can be used twice within 90 minutes of issue [35]. SamTrans offers two classes of service: local, which has a base fare of $1.00 and monthly pass priced at $36; and express, which has base fares between $2.00 and $2.50 and monthly passes priced at $72 and $90 [35]. VTA offers three classes of service, Regular, Express, and Super Express, each of which has its own pricing for single fare, day pass, and monthly pass, as presented in Table 3-1:

Service \ Fare	Base Fare	Day Pass	Monthly Pass
Regular	$1.10	$2.20	$33
Express	$1.75	$3.50	$50
Super Express	$2.25	$4.50	$55

Table 3-1: Valley Transit Authority Fares

VTA also sells books of ten day passes, but they do not provide a discount over the regular cost of the passes. Transfers are not issued, but day passes provide unlimited use at a discount for anyone making more than two trips in a day [35].

3.6.1 Current Fare Integration

There are two major areas of fare integration that must be considered for the San Francisco area: current fare integration strategies that are in place, and the history and future of regional fare integration strategies that have been tried in the past or are currently being studied for future implementation. Currently, a number of *ad hoc* fare integration strategies are in place, making it somewhat confusing for riders (or observers) to understand exactly what the options are. The following discussion is not intended as an exhaustive review of all fare integration strategies in place in the Bay Area, but rather to give a flavor of the different strategies that have been tried. Perhaps the most important fare integration instrument in use is the BART Plus ticket, which is designed for travelers who transfer from one of the local bus services to BART (or *vice versa*) to complete their trip. The BART Plus ticket, which is sold at a face value from $28 to $61 for a half-month ticket, operates both as a BART stored-value card and a flash pass for use on nine local bus operators (AC Transit, BART Express, County Connection, Dumbarton Express, Martinez Link, SamTrans, VTA, Muni, and Union City Transit). The stored-value portion of the card has a value between $15 and $50, with the rest of the cost paying for use on the other participating operators. Although there are some restrictions and limitations on the use of the BART Plus ticket (it is not valid on most TransBay services, and is only accepted as partial fare credit on certain systems), it provides an effective fare integration tool for regular BART users [35].

Muni has a number of fare integration strategies in place in addition to its participation in the BART Plus ticket program. Users who use both Muni and AC Transit

can purchase a sticker to attach to their AC Transit pass, which allows them unlimited rides on both systems. Similar arrangements are also in place with Golden Gate Transit, SamTrans, and Vallejo Ferry. CalTrain riders using a monthly pass can purchase a $30 Peninsula Pass, which entitles them to unlimited rides on all Muni services (as well as certain other operators in the region) [35]. In addition to these pass-based fare integration strategies, Muni also has agreements related to single fares. Tickets for the Alameda/Oakland Ferry are actually three-part tickets that allow riders to board Muni, AC Transit, and the ferry. Passengers disembarking in San Francisco can use the "Muni" part of the ticket to board buses near the ferry terminal, while they can simply show drivers a complete ticket when they board Muni services anywhere in San Francisco to make the trip back to the ferry terminal (a single ticket costs $4, ten-ticket books are $30, and twenty-ticket books are $55). On the East Bay side, the "AC Transit" portion of the ticket can be used to travel to and from the area around the ferry landing. For BART passengers without a BART Plus ticket, two-part transfers can be purchased inside BART stations for the cost of a single Muni fare, with the first part honored as a regular Muni fare for an hour from the time of purchase, and the second half valid for 72 hours from the time of purchase. Through these agreements, Muni accommodates transfers from most of the operators that it interfaces with, but the strategies are fairly complicated and are not particularly convenient or transparent for riders, whether regular or occasional [35].

Like Muni, AC Transit participates in the BART Plus fare integration agreement, although it is not accepted for travel on Transbay routes. AC also sells two-part transfers similar to those used by Muni: inside BART stations served by AC, riders can receive (at no charge) a two-part transfer. The first transfer then entitles them to board an AC Transit bus leaving that station for $1 (a 25¢ discount), while the second part of the transfer also entitles them to board a bus returning to that station (on the next business day) for $1. In this way, regular commuters who do not wish to purchase a BART Plus ticket can still obtain some discount on their transfer. As mentioned above, AC Transit passes can be upgraded for use on Muni with the purchase of an add-on sticker. AC Transit also has limited transferring agreements with Golden Gate Transit (which serves

areas to the north of San Francisco) and VTA, as well as the free transfer to and from the Alameda/Oakland Ferry. Overall, AC Transit does not appear very committed to fare integration, aside from its participation in the BART Plus program. However, given that BART is the most important transfer market for AC Transit services, it does not seem crucial that AC Transit develop other fare integration strategies [35].

SamTrans also participates in the BART Plus fare integration agreement, although the pass only provides a partial credit on most routes, with passengers having to pay an upgrade fare when boarding a SamTrans vehicle. Additionally, SamTrans accepts passes from a number of different operators, including AC Transit, Dumbarton Express, Muni, Caltrain, and VTA, as fare credit on local routes at locations where service areas intersect. In return AC Transit, Dumbarton Express, and VTA accept SamTrans passes as fare credit at shared bus stops. As with AC Transit, SamTrans monthly pass holders can purchase stickers that give them unlimited rides on all Muni services [35]. VTA also has similar fare integration agreements with operators in the area, including SamTrans (pass), AC Transit (transfer or pass), Dumbarton Express (transfer or pass), BART (BART Plus and transfer), and Caltrain (pass with Peninsula Pass sticker). These instruments are valid for a free transfer to SamTrans regular service, and as fare credit on Express and Super Express services [35].

3.6.2 Previous Efforts

Before looking at the future plans for fare integration in the San Francisco area, it is interesting to look at its history. The San Francisco Metropolitan Planning Organization, the Metropolitan Transportation Commission (MTC), has made a number of previous efforts at fare integration that have led to the strategies currently in place. In 1978, MTC received a federal grant from the Office of Service and Methods Demonstration to pursue a joint fare prepayment demonstration in the Bay Area. In 1980, the need for improved fare integration (which had been under study for almost 25 years) was reinforced by a financing crisis that led to increased fares on the three largest operators and created a climate where money for fare integration could be identified. Because of this, the original grant was reoriented to focus on implementing a new pass for

these three operators (AC Transit, Muni, and BART) [36]. Given the different fare structures in place (ranging from flat fare to finely graduated distance based), it was clear that this was going to involve some compromise. The product of this process was a joint pass allowing ridership on all Muni and AC Transit services (including TransBay service). This was implemented by selling a regular AC Transit pass with a Muni sticker attached at the time of purchase. Given that there was no regional fare structure in place, the pass was priced at a $2 discount below the price of the individual passes, providing some incentive for riders to purchase the pass while minimizing the operators' revenue loss [36]. Initial sales of the pass were above what had been predicted by some very simple *a priori* modeling, but were within the general range that was expected.

To better understand how the pass was being accepted, MTC conducted a survey of riders who were using the pass. The majority of those surveyed were people who had previously purchased both passes anyway, but about 30% had previously bought only one pass (or had not been using a pass). The survey also found that about 6% of the riders using the pass were in fact new riders, showing that the discount did generate some new ridership [36]. The survey also looked at people's reason for purchasing the pass. Although saving money was clearly the most important reason (the importance being inversely related to income), a significant number of users mentioned the convenience of not having to carry two passes or find exact change as an important element of their decision. Overall, this pass was felt to be a success, and paved the way for other fare integration efforts that took place in the next few years [36]. A similar system of unlimited use passes with stickers for use on additional systems was implemented on CalTrain, SamTrans, Santa Clara Regional Transit District (now VTA), and Muni [37]. This was the beginning of the current Peninsula Pass program which is still in place [35].

In April 1983, MTC introduced the next tangible product of this fare integration effort, a joint BART/Muni pass, which replaced the existing Muni pass. This pass provided unlimited rides on all Muni routes, as well as between all BART stations in the San Francisco area. Since purchasing this pass and a regular AC Transit pass cost only $2 more than the original joint AC Transit/Muni pass, it eroded the market for that first fare integration strategy (since riders could not get unlimited use of BART with the existing

AC/Muni pass). The new BART/Muni pass was quite successful, particularly since a temporary budgetary windfall allowed for a pass price reduction at approximately the same time [38]. The next step in this effort at fare integration was to develop a joint fare instrument for use on both BART and AC Transit, as well as an instrument that would work on all three operators. MTC began pursuing the concept of a value-based pass that would allow unlimited rides of a certain value on all three systems. A rider would then buy a pass of the value required for their most common trip; they could also use the pass for any trip of an equal or lesser value, and would pay an upgrade charge for trips with a higher value. However, none of the three operators was particularly interested in this concept, for two main reasons. First, it would have required greater coordination in fare structure than had been achieved in the past, requiring each agency to relinquish more authority than was felt to be acceptable. Secondly, the potential for revenue loss due to an unlimited use card of this type was felt to be unacceptable [38].

To overcome these objections, MTC reversed course, and started to look at using BART stored-value technology on buses, rather than implementing bus-oriented unlimited use passes on BART. The eventual goal was to implement stored-value cards on buses, but the short-term result was a joint ticket, known as AC/BART Plus, introduced in 1987, which could be used as an unlimited use pass on AC Transit and as a stored-value card on BART [38]. Basically, the card was a BART stored-value card with an AC flash pass printed on the reverse side. For a number of logistical reasons, this instrument was sold for a half-month period (to reduce the per pass cost) in only eight set BART values. The passes could not be reloaded, and therefore users who exhausted the BART value before the end of the month had to purchase a separate BART card (since the cards could not be reloaded, a last-ride bonus was provided, so that users could always exit the system, independent of the value left on the card) [38]. This original AC/BART Plus pass is the fare instrument that eventually grew into the full BART Plus ticket described earlier. The ticket was first extended to include Muni in 1989, and other operators have been added over the intervening years [37]. The BART Plus fare instrument appears to have been quite successful, judging by its extension to other operators. Logically, it makes sense that this type of regional fare integration should be

based around BART, since it is the regional transit system that integrates the geographically dispersed operators, particularly in the East Bay.

MTC remained concerned with the longer-term goal of implementing the BART stored-value technology on the various bus systems, since this would provide a flexible framework for fare integration without requiring agencies to agree on the same pricing structure. These efforts led to the first Translink "Universal Ticket" project, which was intended to demonstrate the application of stored-value magnetic cards. MTC started with the equipment used on BART and developed compatible fareboxes for use on buses, which were supplied by CGA of France [39]. These fareboxes were installed on 112 buses operated by the Central Contra Costa Transit Authority, which operates service in the Contra Costa County suburbs to the east of Oakland, as well as on 45 BART Express buses that feed BART. BART fare gates were also modified to accept the new tickets at all stations, and changes were made to the vending equipment to allow the tickets to be sold and updated [37,39]. The system was designed to deduct the appropriate fare for whatever trip was being taken, with each agency remaining free to determine the fare that they would charge. The fareboxes printed the remaining value in two columns, with one column indicating the value deducted by buses and the other column indicating the value deducted by BART.

Overall, the first TransLink program was not very successful, due to a combination of technical and customer acceptance difficulties [37]. The fareboxes that were installed on the buses were unreliable, and did not perform well in the relatively harsh environment of a bus. Because the cards had to be read and then printed on for each boarding, the equipment needed to be very precisely maintained to ensure the ticket was transported properly, and this proved to be quite difficult on buses. In addition, there were problems with customer acceptance of the system, meaning that the new cards were not well used. Exacerbating the equipment problem was the fact that CGA decided to leave the US market, making it difficult to maintain the equipment and make modifications as necessary. In addition, during the period of the test (1993-1995), smart card technology began to become technically and economically feasible, and many systems began to consider implementing stored-value smart cards, rather than stored-

value magnetic stripe cards. With all these factors coming together simultaneously, it became clear that it did not make sense to expand the original TransLink system, and that efforts should be made to develop a more reliable fare integration system based on the use of smart cards. This led to the second TransLink project, which is currently moving towards testing smart cards on buses and rail in the Bay Area.

3.6.3 Future Plans

The second incarnation of TransLink moved away from the idea of maintaining the current fare technology used by BART, and focused instead on new technologies (which BART was also beginning to study). MTC began the process by working with the staff of the different operating agencies, to detail their concerns about these new technologies as well as their requirements for implementation [37]. The hope was that this early consultation would make it possible to develop a system that would satisfy all the major agencies involved. The basic idea behind TransLink is to provide a common fare payment medium for all operators in the region, so that riders can count on using one fare instrument for all rides. TransLink is intended to be extremely flexible, so that individual transit agencies can decide their own fare policies and then implement them easily using TransLink as the payment medium. Once this general payment system is in place, intra-operator and inter-operator fare integration can be more easily implemented, since all operators will be using the same medium. However, TransLink is aimed first at serving the internal needs of each operator, with inter-operator issues a secondary (although still important) element of the program [40].

Technologically, MTC is pursuing a smart card approach. The different alternatives, ranging from magnetic stripe to full contactless smart card, were evaluated by the project consultant, who reached the conclusion that contactless smart cards are as good as or superior to the other technologies in all areas [41]. Because of the distributed intelligence of smart cards, pricing can be quite flexible, with the card charging different fares and storing different transfer information for each operator. TransLink is expected to have increased reliability and decreased maintenance costs compared to the current system, because the smart card readers require no moving parts and can be quite small.

Because of this lack of moving parts and because of the remote communications system used with contactless cards, these smart cards are also expected to increase throughput of people boarding buses and entering the rail system. The system is also expected to be modular and upgradeable, as well as providing the possibility of participating in a larger "open" system where smart cards are used for a variety of payments, much as cash is used currently. Finally, smart cards also have superior data collection possibilities, which can be used both for general planning and for allocation of fare integration revenue based on number of boardings.

The major elements of the TransLink procurement are as follows: fare collection equipment for use on all vehicles and in rapid transit stations; a system for data collection and distribution; services for distribution of the smart cards and maintenance of the fare equipment; and clearinghouse services for allocating the revenue collected between the different operators based on the number of trips taken on each operator. This last clearinghouse element, which is always important in implementing fare integration, is a key part of the project, even in the absence of any specific fare integration strategies. Under the TransLink system, very little money will actually be collected in fareboxes, with most being collected at locations that sell smart cards, or wherever the cards are reloaded. This money must then be collected and distributed to individual operators based on ridership information gathered from the verification of smart cards. Since this clearinghouse will have to exist in any case, the logistical elements required to implement fare integration will largely have been taken care of and all that will need to be developed will be an integrated pricing structure. Currently, TransLink plans to begin the bidding process for this system in the summer of 1997, with a test taking place in late 1997 and early 1998, for a period of one year. Based on this test period, MTC will decide how to further pursue this initiative for system-wide implementation.

3.6.4 Conclusion

The different public transit operators in the San Francisco Bay Area have implemented a number of interesting fare integration strategies, mostly without the use of expensive technology. In particular, the use of two-part transfers that are tied to the rail

operator provides an interesting way of implementing bi-directional fare integration without the individual bus operators having to issue any transfers. In contrast, WMATA only issues transfers when going from rail to bus, and not in the opposite direction, which can be a serious inconvenience to riders. MTC is also on the leading edge of the deployment of new technologies on a regional basis, and it will be interesting to follow the progress of the current TransLink program. MTC is taking a reasoned approach to this process, and the end result should provide a window into the future of fare collection and in particular inter-operator fare integration. Although the current fare integration strategies in place are somewhat haphazard and complicated, there has been a general movement towards standardizing fare integration to make it more transparent for both riders and operators. However, it is important that MTC also continue to pursue pricing integration, to realize the full benefits of the integrated fare technology.

3.7 London, UK

London Transport (LT) is responsible for providing or securing public transportation services in the Greater London area, on both bus and rail. London Transport owns and operates London Underground Limited (LUL), which provides subway service throughout Greater London. Bus service is currently controlled by London Transport Buses, a department of LT, which is responsible for managing the contracts with the various private companies that provide bus service in Greater London [42]. LT is also responsible for system planning and design, and is directly involved in developing and implementing all aspects of fare policy. The current London Transport fare system is based on a system of concentric zones, with six zones for the Underground and four zones for buses (the outer three Underground zones form a single bus zone). Over the years, London Transport has been quite thoughtful about its fare policy, and appears to have put a fair amount of effort into developing a consistent fare policy. In particular, LT has set out four main objectives in its fare policy and pricing decision making, attempting to ensure that prices:

- Reflect the operational and capital costs of travel;
- Are perceived as fair and reasonable;

- Encourage mobility and access to London's facilities;
- Help relieve London's traffic and environmental problems [43].

In its implementation, the fare policy is fairly complicated, with differing structures on bus and rail, and a wide variety of different fare instruments. On the Underground, individual fares can be purchased in both single and return tickets, with the price differing depending on the number of zones in which travel will take place and whether the traveler is planning to travel within or though zone 1 (the innermost zone) or between the outer zones. Fares range from £0.80 for a single fare within one zone outside of zone 1, to £3.20 for a traveler going from zone 1 to zone 6. In addition, books of ten tickets for travel within zone 1 only are available for £10, providing a 10% discount over the base fare. Bus fares are considerably lower, ranging from £0.50 for a trip in zones 1 and 2 to £1.20 for a trip in all four bus zones [42].

LT also offers a wide variety of passes targeted at specific market segments. These passes are generally known as Travelcards, and have a period of validity ranging from part of a day all the way to an entire year. Season-ticket Travelcards (known as passes in the US) are available in weekly, monthly, and yearly values, with differing prices depending on how many zones are included in travel and whether the ticket can be used in zone 1. Table 3-2 provides a summary of the season tickets available [42]:

	Weekly		Monthly		Annual	
	Minimum	**Maximum**	**Minimum**	**Maximum**	**Minimum**	**Maximum**
Including Zone 1	£13	£33	£50	£126.80	£520	£1320
Outside Zone 1	£6.90	£21	£26.50	£80.70	£276	£840

Table 3-2: London Transport Travelcard Season Ticket Prices

LT also offers a single-day unlimited use card, known as the LT card, which is sold at a cost of £4.30 for zones 1 and 2, £6.00 for zones 1-4, and £7.20 for zones 1-6.

In addition to these cards aimed mainly at regular, experienced users, LT also offers a range of One Day, Weekend, and Family Travelcards. The One Day Travelcard is aimed mainly at tourists, and is valid only after 9:30 am, to prevent use during the

morning peak when LT transit service is busiest. The One Day Travelcard is priced at £3.20 for zones 1-2, £3.60 for zones 1-4, £4.00 for zones 1-6, and £3.00 for zones 2-6. Similarly, the weekend Travelcard is valid for unlimited use for a weekend, and is priced at £4.80 for zones1-2, £5.40 for zones 1-4, £6.00 for zones 1-6, and £4.50 for zones 2-6 [42]. Finally, LT sells a Family Travelcard that can be used by two adults with between one and four children. These cards are priced at £2.50 for zones 1-2, £2.80 for zones 1-4, £3.20 for zones 1-6, and £2.40 for zones 2-6. Each adult must purchase a ticket, while the children traveling with them are charged a flat fare of 50p. Although this Family Travelcard pricing is somewhat complicated, it does provide a discount to families traveling together [42].

In addition to the Travelcards, which are valid on both bus and underground, LT also offers a series of lower priced bus-only passes. As with the regular bus fare, these are priced lower than the regular underground fare, given the differences in the services. One-day passes are available for £1.80 for travel anywhere outside zone 1, and for £2.70 for travel anywhere in the system. Passes are also available in weekly, monthly, and yearly lengths, as shown in Table 3-3 [42]:

Zone(s)	Weekly	Monthly	Yearly
1, 2, 3, & 4	£12.00	£46.10	£480
2 or 3 or 4	£6.20	£23.90	£248
2, 3, & 4	£8.50	£32.70	£340

Table 3-3: London Transport Bus Pass Fares

3.7.1 Current Fare Integration

Since the early 1980s, LT has been pursuing two specific goals in its fare policy; simplification and integration [44]. The first goal, which has led to significant changes in fare policy, considers how much complexity is really needed to reach the goals of a transit agency. Although the current LT fare policy is complicated compared to many North American systems, it has been simplified considerably over the past fifteen years from the former finely graduated, distance based system. The second goal, which is of greater concern in this research, is to develop new and modified fare instruments that will make travel by public transit more attractive and less expensive [44]. The Travelcard system is

currently the major outgrowth of this goal, and acts as the major vehicle for fare integration for London Transport. Not only are Travelcards valid for travel on both bus and underground, but they can also be used on many British Rail commuter services in Greater London, as well as the Docklands Light Railway that provides service to the Canary Wharf area of London [42].

Originally, Travelcards were valid only on LT services, while a separate instrument, known as the Capitalcard, was valid on both LT and British Rail services. However, these two instruments were merged together into a single Travelcard in 1989, since the price differential between them had been diminishing over time [44]. LT sees Travelcards as offering frequent users a travel product that is similar to a car, since users justify their purchase based on their regular journey (to work, school, or elsewhere) and any extra travel is basically free. This gives users a large amount of freedom to use the system to their maximum benefit, and encourages high use once the pass has been purchased. Travelcards also provide benefit to the operator, in terms of encouraging use of rail for longer line-haul trips, and opening up new bus markets to feed stations and serve off peak and local trips [44]. Currently, revenue allocation for the Travelcards is done based on surveys of usage patterns. However, this method is not completely reliable, which is of particular concern when this revenue is being allocated to private operators who must make a profit. As discussed in the next section, technological advances should help to improve this process considerably.

3.7.2 Future Plans

Overall, the movement towards fare integration in London has been quite successful. LT has tracked significant increases in the use of integrated tickets since their introduction, and there have been significant increases in ridership in the period since the Travelcard was introduced. Revenue has also increased in this period, and about 30% of additional Travelcard revenue has been "new" revenue, not revenue diverted from other tickets sales, indicating that Travelcards have attracted new riders and expanded the market. Much of this traffic expansion has taken place off peak, meaning that cost impacts have been minimal [44]. LT research estimates that the various Travelcards

create an annual benefit (in 1992 prices) of £135 million on buses (£15M in revenue benefit and £120M in passenger benefit), and £275 million on the underground (£60M in revenue benefit and £215M in passenger benefit). In addition, this analysis shows an annual benefit of £50 million from a 1% decrease in car traffic levels as a result of Travelcards [44].

Following the success of the Travelcards, LT, like many other public transit agencies, has begun to investigate the potential of smart cards as a fare payment technology. Currently, LT uses a combination of magnetic and visual verification to ensure ticket validity. Tickets, which are made of cardboard or plastic, are magnetically encoded, and on central-area Underground stations, magnetic readers verify the validity of tickets before allowing a rider to enter or exit the station. On more remote LT stations and on buses, this verification is done visually by the driver or station attendant. In addition, fares are checked on board vehicles to further reduce the potential for fare abuse [45]. LT is investigating smart cards for two principal reasons: revenue allocation and stored-value ticketing. The issue of revenue allocation is particularly important in London because of the contracting of bus services, in some cases using net cost tendering (where the operator is paid only the difference between the revenue collected and their operating costs). Smart card should allow the elimination of survey-based revenue allocation, because they provided highly detailed information (down to the level of individual cards), making this process more reliable and equitable. In addition, this ridership information can be quite useful for service assessment and planning purposes [44].

Smart cards also provide the opportunity for implementing stored-value ticketing, as is currently in use in San Francisco and Washington (among many examples). The vision is that stored-value cards would provide many of the pricing and convenience advantages of Travelcards to less intensive users. In this way, users who currently pay single fares and marginal Travelcards could switch to smart cards, and realize many of the associated benefits, including discounted transfers and daily or weekly cost maximums. This would allow LT to move all but their most casual users into the use of some sort of fare-card, which could reduce costs and improve throughput [45].

LT has undertaken limited trials of smart cards in the Harrow area of London. These tests appear to have been fairly successful, and LT is moving forward with preliminary plans to implement smart cards on a larger scale [44]. LT is combining this with a plan to contract out revenue operations, and the status of this effort is currently unclear [45]. However, LT seems committed to implementing smart cards, and based on past fare policy and technology innovations, it seems likely that the agency will proceed with this plan in the near future.

3.7.3 Conclusion

London Transport provides an interesting example of a transit agency that has made a strong commitment to integrating fares, and has followed through on this commitment with innovative new policies. Based on their research, this policy has had an important positive impact on both passengers and operations. This analysis is particularly noteworthy because it appears to be very rare that a public transit agency analyzes the impacts of fare integration quantitatively and attempts to put a dollar value to the policies that have been implemented. In many cases *a priori* evaluations are performed in anticipation of changes in fare policy, but these are often quite speculative, making it difficult to place any confidence in the results. Although LT research does not explicitly link these benefits to the cost of implementing fare integration, this still represents an interesting effort that does not appear to have been duplicated elsewhere. To be fair, many transit agencies are not as explicitly oriented towards fare integration as LT, so they are unlikely to be as specifically concerned about fare integration impacts. Overall, LT has been quite successful with its fare integration alternatives, and its experiences can be used to inform the planning and implementation of fare integration in other locations.

3.8 Santiago, Chile

Metro S.A. in Santiago, Chile, currently operates a publicly owned, rubber-tired subway system serving two of the main corridors in the Santiago area (with a third line under development). The fare structure of the subway system is somewhat complicated, with differential pricing based on time and, to some extent, line of travel. Travel is divided into three time periods, high (morning and evening peak), medium (midday and

evening), and low (early morning and night). In addition to single and return tickets, fares are also sold in magnetically encoded stored-value cards. These cards, which are sold in a single denomination of 1,500 Chilean pesos, entitle the holder to a discount over the regular fare, with the discount being greater on Line 2 than on Line 1. The fare structure is shown in Table 3-4 (all monetary amounts are in pesos):

Time Period	High	Medium	Low
Stored-Value Card Single Ride (Line 1)	180	150	100
Stored-Value Card Single Ride (Line 2)	155	140	100
Round-Trip Ticket	350	350	350
Single Ticket	190	160	100
Reduced Fare	50	50	50

Table 3-4: Santiago Metro Fare Structure

In addition to the subway system, Metro S.A. oversees a network of buses (known as Metrobus) that feed the subway stations. Started in 1987, the system was created to compete with the deregulated private bus operators (described below) to ensure that the subway was properly fed by services charging a reasonable fare. The private bus companies were re-regulated in the early 1990s, and since then the private feeder service has improved considerably, but the contract service still continues. In 1995, the system consisted of 20 routes serving five metro stations, operated by fifteen private operators with over 500 buses. Base fare on the Metrobus is 160 pesos, while reduced-fare tickets (student and elderly) are 50 pesos [46].

In addition to the system operated by Metro S.A., public transit service is also provided by a network of private bus, minibus, and shared-taxi services. During the 1970s and 1980s, these services were deregulated with respect to fares and services, leading to increases in service extent and frequency, as well as higher prices. Following this deregulated period, a number of factors began to push towards re-regulation, including complaints about high fares and safety problems, a need to reduce vehicular congestion and exhaust emissions, and a desire to reduce competition that was hurting the public metro system [46]. As a result of these pressures, the government initiated a program to buy back high-emissions public transit vehicles, and began the process of re-

regulating the bus and minibus companies. Operators now bid for exclusive access to certain streets for three to five years, with decisions made based on the quality of the proposed service rather than the cost. These changes have been successful, and have led to reduced congestion and reduced fares. Fares for the bus system vary based on the corridor, and are set by the operators based on standard fares set by the government. Operators can choose to set their fare lower than the standard fare decided by the government, with this lower fare being a bargaining point in the route franchising process [46].

3.8.1 Current Fare Integration

Fare integration between the Metro and Metrobus system is in the form of a joint ticket that is valid for a single trip on both Metro and Metrobus. This tickets is priced at 280 pesos, of which 150 pesos is for travel on Metro and 130 pesos is for travel on Metrobus. This ticket, which is sold only in Metro tickets offices, is valid at any time of day. This combined ticket provides a saving of 70 pesos during the high-fare period and 40 pesos during the medium-fare period, while there is no price advantage during the low-fare period.

3.8.2 Conclusion

Overall, fare integration in Santiago is not very widespread, but the use of a combined, discounted ticket between Metro and Metrobus is an important step in the right direction. As with London, this bus system is privately contracted, making fare integration more difficult to implement. What would be more interesting, as well as more difficult, would be to implement fare integration between the Metro (and Metrobus) and the privately operated buses and minibuses. This would be particularly instructive for the San Juan area, because of the similarities between the públicos in San Juan and the private minibuses in Santiago. However, even without that added aspect, Metro S.A. provides an interesting example of fare integration in a context that share some similarity with the San Juan Metropolitan Area, including private (although contracted) operators.

3.9 Conclusions

These case studies provide an illuminating overview of the current status of fare integration in agencies around the world. Hopefully, these experiences will inform the development of fare integration strategies elsewhere so that other agencies can benefit from the experience of others. The fare integration strategies in use at each case study site are summarized in Table 3-5, divided into the three major categories of transfers discounts, period passes, and stored-value cards.

Case Study	Transfer Discounts	Period Passes	Stored-Value Cards	
			Implemented	Under Study
NYCT	- bus / bus - bus / rail (under study)	- commuter rail - bus / commuter rail	- bus / rail (mag-stripe)	- bus / rail / commuter rail pass (mag-stripe and smart card)
WMATA	- rail to bus (intra- and inter-operator)	- rail - bus - rail / bus (intra- and inter-operator) - rail / commuter rail	- rail (mag-stripe)	- bus / rail / parking (smart card)
STCUM	- bus / rail / commuter rail	- bus / rail / commuter rail (intra- and inter-operator)		- bus / rail (intra- and inter-operator; mag-stripe and smart card)
MTDB	- bus / rail / paratransit (intra- and inter-operator)	- bus / rail / paratransit (intra- and inter-operator)		- bus / rail (intra- and inter-operator)
SCAT	- bus	- bus	- bus (intra- and inter-operator; smart card)	
Bay Area	- bus / rail / ferry (intra- and inter-operator)	- bus - bus / rail stored-value card (intra-operator) - bus / rail / commuter rail	- rail (mag-stripe) - rail / bus pass (inter - operator; mag-stripe)	- rail / bus / commuter rail / ferry (intra- and inter-operator; smart card)
LT		- bus - rail / bus / commuter rail		- bus / rail (smart card)
Metro SA	- bus / rail (combined ticket sold at discount)		- rail (mag-stripe)	- rail / bus (smart card)

Table 3-5: Summary of Fare Integration in Use at Case Study Sites

These case studies illustrate the diversity of experience with fare integration, and demonstrate the different techniques that are possible. Because of this diversity, it is difficult to draw any overarching conclusions from the case studies. However, it is possible to discern a few general themes that run through all of the case studies, and these are summarized in the following sections.

3.9.1 Role of Technology

Clearly, the over-riding element that is common to the majority of these case studies is the current interest in technological solutions, particularly the use of smart cards. Almost all of the agencies are either in the process of implementing smart cards, are currently studying smart cards, or are beginning to investigate the possibilities. Smart cards do provide a number of interesting capabilities, including increased flexibility, superior data collection, and the potential for multiple uses. However, it is also interesting to see what can be done without the use of any significant technology, as in the Uniform Fare Structure Agreement in San Diego and the two-part transfers used in San Francisco. Although it seems clear that smart cards will play a very important role in the future of fare systems and fare integration, it is important to remember that technology is a means to an end, and not an end in itself. This is not to say that smart cards are "a solution looking for a problem," but rather that policy should drive technology, not the other way around.

3.9.2 Importance of Pricing Integration

Although increased convenience is certainly a valid aim, it seems clear that it is pricing actions that really affect behavior. As mentioned above, the use of smart cards is becoming increasingly important for fare integration, but it is unlikely that they will ever substitute for actual price incentives in terms of their behavioral impact. The UFSA in San Diego demonstrates the importance of having a central agreement that details pricing integration and provides a methodology for revenue allocation. Although technological integration clearly has a very important place, in the end, fare integration is likely to be truly successful only when an attempt is made to tackle pricing issues.

3.9.3 Role of Private Sector

As the private sector becomes increasingly involved in public transit service operation, it is important to consider how this will affect fare integration, and *vice versa.* In the case of pricing, it will be important to look at the cost and revenue structure of contracts, to ensure that private operators are able to participate in fare integration and that they can be integrated into the process in a way that is satisfactory to all parties involved. In the case of technological integration, private sector participants must be encouraged to use compatible technologies, to prevent fragmentation of the fare system. Without these efforts to hold together the integrity of an integrated system, participation of the private sector may wind up creating major problems in long-term policy. It will be instructive to watch as agencies such as London Transport deal with these issues.

3.9.4 Frequency of Use

In light of the current popularity of smart cards, which have a relatively high unit cost, the issue of frequency of use becomes more important. For frequent users, the cost of a smart card may become negligible, because they may use the card for a year or more before it wears out or is lost. However, in the case of infrequent users who now pay with cash, some medium has to be introduced that will allow them to use the system without the rider or agency having to take on the high cost of the smart card. Potential solutions include the joint use of magnetic stripe cards and the use of special recyclable smart cards that will be captured when the value is exhausted. In addition to this technological issue, there are problems related to the increasing complexity of fare systems and the barrier that they can create, as well as to the need to provide sufficient locations for potential customers to purchase fare media. Although this problem has always existed, the growing importance of smart cards will necessitate the development of creative solutions.

4. Analytical Framework

As discussed in Chapter Two, Fleishman's research proposes a general methodology for developing and evaluating fare policy decisions. Although this methodology is helpful, in this general form it is not directly applicable to evaluating fare integration strategies. The first section of this chapter therefore modifies this methodology, to make it specific to the development of fare integration policy and technology. Following this, the strategy evaluation section of the methodology (as opposed to the strategy development section) is developed in greater detail. The analytical framework proposed in this chapter defines this evaluation process in greater detail by developing a series of evaluation criteria and proposing a methodology for analyzing potential strategies in the context of these criteria.

4.1 Framework for Fare Integration Decision-Making

As with the general fare system development, it is helpful to think about the development of a fare integration system as a structured methodology. Although some articles do review the necessary steps in fare integration, none lays out a general methodology that can be followed [1,13]. However, based on these descriptions, along with the methodology described by Fleishman, it is possible to propose a general framework for developing fare integration. In particular, Rinks cites three major elements that should be considered in the development of an integrated fare system [13]:

- The methodology for pricing integrated transit trips;
- The methodology for collecting fares for integrated transit trips;
- The methodology for allocating revenue collected from integrated transit trips.

Integrating these three elements into the general methodology developed by Fleishman yields the framework shown in Figure 4-1. The specific elements of this framework are described below:

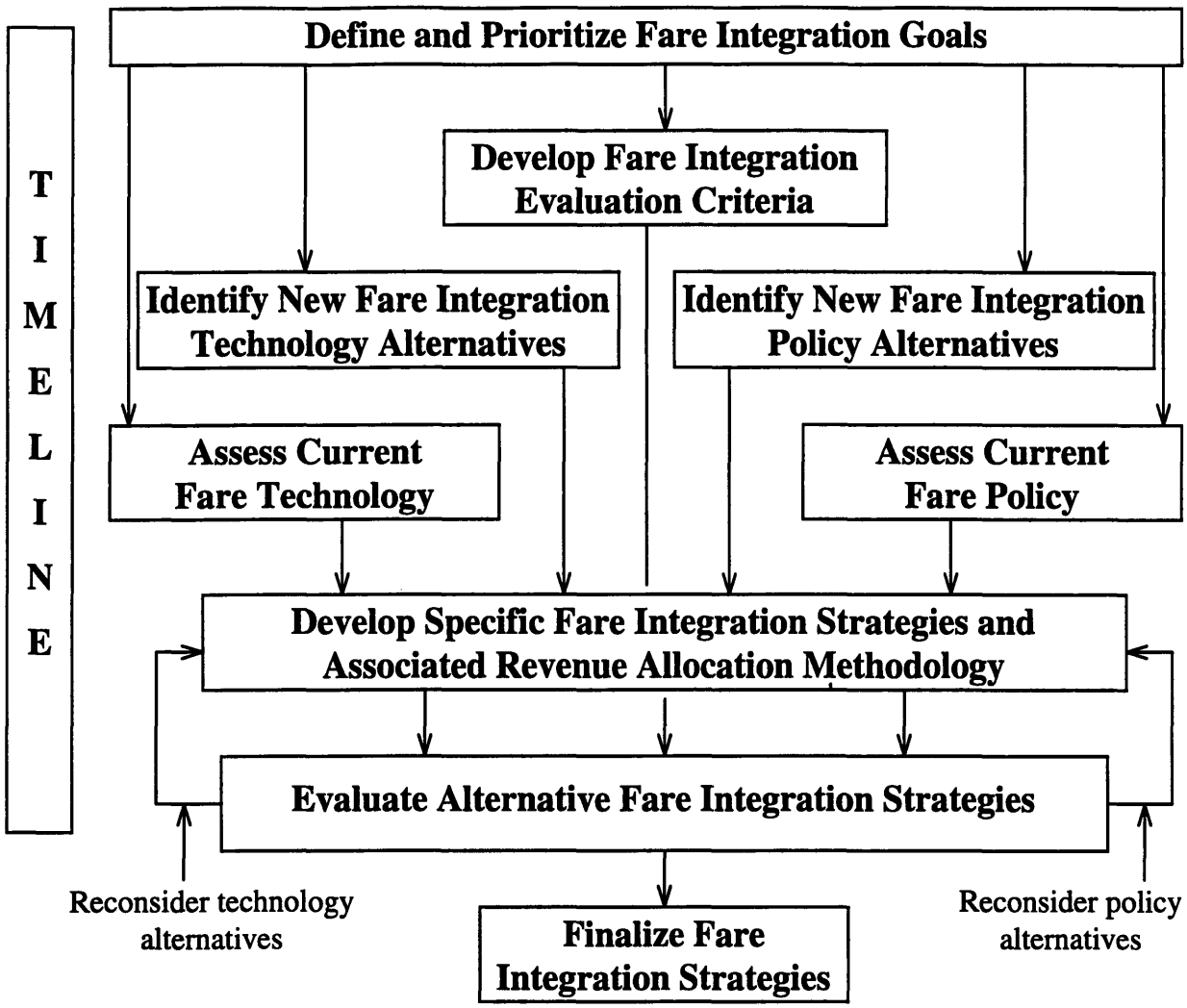

Figure 4-1: Framework for Fare Integration Decision-Making

- **Define and Prioritize Fare Integration Goals** - Develop an overall set of goals for fare integration, to force agreement on priorities that will guide the decision-making process (even if the individual agencies have competing goals).
- **Develop Fare Integration Evaluation Criteria** - Based on these goals, define a set of evaluation criteria to be used in assessing potential fare integration strategies.
- **Identify New Fare Integration Alternatives (Technology and Policy)** - Develop potential technology and policy alternatives that will help to meet the fare integration goals initially agreed upon.

- **Assess Current Fare Technology and Policy** - Examine the current fare system, to determine what changes to the current fare system are required to implement the fare integration alternatives identified.
- **Develop Specific Fare Integration Strategies (and Revenue Allocation)** - Based on the alternatives identified and the assessment of the current fare system, develop the specific fare integration strategies (and the accompanying revenue allocation methodology), including any necessary modifications to the current fare system.
- **Evaluate Alternative Fare Integration Strategies** - Using the evaluation criteria developed, evaluate the specific fare integration strategies to determine whether they are worth integrating (either individually or as a package). Based on this analysis, modify the strategies to mitigate the negative impacts identified.
- **Finalize Fare Integration Strategies** - Following this iterative analysis process, finalize the specific fare integration strategies (including elements such as approval by the General Managers and Boards of Directors, and satisfaction of legal and regulatory requirements).

Throughout this analysis of fare integration, it is also important to keep in mind the timeline on which the agency is operating, to ensure that the necessary decisions are made at the appropriate times.

4.2 Motivation for Analytical Framework

The specific focus of this analytical framework is two boxes in the methodology described above: "Develop Fare Integration Evaluation Criteria" and "Evaluate Technologies, Policies, and Revenue Allocation Methodology" The remainder of this chapter will propose a set of criteria for evaluating fare integration strategies, and then propose a method for dealing with each criterion. The development of this methodology is motivated by the fact that previous attempts to evaluate fare integration strategies before implementation have been weak. As discussed in Chapter Two, many analysts simply see fare integration as a "good idea", and make little attempt to justify this claim

[10]. Although it is possible to hypothesize many ways in which these positive impacts can occur (as discussed in Chapter 1), it is rare to see substantive quantitative or qualitative analysis of these impacts before fare integration is implemented [9,47].

Looking at previous examples of fare integration, there are two major reasons why it is difficult to perform an *a priori* evaluation of fare integration [1,48,49]:

- **Evaluation Criteria** - Fleishman defines a set of measures for evaluating fare system decisions, but these criteria may not be directly applicable to fare integration strategies. Certain factors used in evaluating the overall fare system are not relevant to fare integration strategies, while other factors may need to be added in evaluating fare integration strategies. The first part of the analytical framework develops criteria for the evaluation of specific fare integration strategies.
- **Application of Evaluation Criteria** - Even if a set of evaluation criteria has been developed, it can be quite difficult to analyze some potential impacts. Determining the impacts of a strategy will require a deep understanding of both the strategy and the context in which it is being considered (including both the transit system and the political, economic, and social environment in which it operates). The second part of the analytical framework provides some guidance about the general impacts of different fare integration scenarios in the context each criterion identified above.

4.3 Fare Integration Evaluation Criteria

This section lists the criteria for evaluating fare integration strategies and describes the impacts of general fare integration strategies for each criterion. For each of the general criteria presented in Chapter Two, a decision is made about whether to include or exclude it from the evaluation of fare integration strategies. In certain cases, criteria that are similar will be combined together to simplify the evaluation, while one new criterion is introduced based on the results of this research. For each criterion chosen for inclusion, there is a brief discussion of a potential method for estimating the impact. For quantitative criteria(such as ridership and cost), specific methods for predicting the impacts are suggested. If a criterion cannot be analyzed quantitatively, there is a discussion of the important issues that should be considered in the analysis. There is also

a discussion of how each of the three major fare integration options (discounted transfers, period passes, and stored-value cards) performs according to each criterion.

4.3.1 Internal Criteria

4.3.1.1 Usage Criteria

Ridership

Ridership is retained as a criterion, both because it is an important measure of transit system effectiveness, and because of the effect that fare integration can have on ridership as a result of cost and convenience. To analyze the impact of fare integration strategies, it is useful to have some model that can predict ridership changes. Without such a model, an analyst will need to use information about previous ridership responses to system changes, or rely on their own experience and judgement about how ridership will change.

Because ridership has always been an important input into transportation decision-making, relatively sophisticated ridership modeling techniques have been developed. It has been common practice to analyze ridership using elasticity models, which are based on observed elasticities of demand with respect to price and other travel characteristics [50]. Although this type of analysis is fairly straightforward, and can be useful for preliminary evaluation, the credibility of the results is questionable, because they are heavily dependent on the prevailing conditions at the time they were estimated. More recently, econometric demand modeling techniques have been used to produce more reliable estimates. In these models, many different explanatory variables can be included, making it easier to isolate the effects of individual factors that are being changed. These models also provide estimates of the elasticity, but do so using a much more sophisticated process. Demand models do have their limitations (such as being data intensive), but they are preferable to simple elasticity models for modeling the ridership impacts of fare integration strategies.

Impact of Fare Integration Strategies

- **Transfer Discounts** - Transfer discounts will result in ridership increases, because ridership tends to increase as price decreases (which will happen for transfer trips), although predicting the magnitude of this change can be difficult.

- **Period Passes** - The impact of passes will depend on how they are priced. If a pass provides a significant discount for a typical traveler, the pass will become popular and lead to increased ridership (since the marginal cost of additional trips is zero). However, if the pricing does not provide a meaningful discount for most frequent travelers, the market penetration of the pass will be low, leading to a small ridership impact. Experience in London demonstrates the potential for passes to create significant ridership increases.

- **Stored-Value Cards** - Stored-value cards are unlikely to have a major effect on ridership, because they mainly provide increased convenience. However, little work has been done on measuring the impact of stored-value cards on ridership, so this conclusion is not certain. As systems in New York City, Montreal, and San Francisco move towards stored-value card implementation, more information about the impacts of these technologies may become available.

Demand Management

This criterion is retained because of the impact fare pricing integration can have on the ability of an agency to manage demand. As an example, the implementation of a period pass could undermine the ability of a transit agency to use pricing incentives to shift travel out of the peak, since there are no limitations on use. This issue can be considered qualitatively, by analyzing the fare structure to see if the changes created by fare integration will change the incentives that are used to shift demand in desirable ways. It may also be possible to look at this issue quantitatively, using modeling techniques to determine the temporal and spatial impacts on demand, but it is unlikely that this level of detail can be represented accurately. However, segmented elasticity measures can be used to identify and then analyze high-elasticity segments of the population who will respond to demand management techniques. In addition, it is important to consider both

the demand management impact of the specific fare integration strategy being analyzed, and the general impact that this strategy will have on the demand management techniques used in the entire fare system.

Performance of Fare Integration Strategies

- **Transfer Discounts** - Transfer discounts are mainly an add-on to the fare system, and are unlikely to impact demand management techniques being used. However, transfer discounts do extend the validity of a fare paid, so it is possible for people to pay their fare during a lower demand period, and then use the transfer during a higher demand period, thereby circumventing demand management techniques in place.
- **Period Passes** - Passes create the greatest problems with demand management, because they are generally valid at all times, thereby undermining the ability of the public transit agency to use fare policy to affect demand. In London, this problem is partially resolved for One-Day Travelcards by limiting validity until after the morning rush hour (although they are valid during the evening rush hour). This kind of approach can be used to limit this problem, and illustrates the importance of thinking about how a certain pass strategy might undermine the effectiveness of demand management techniques.
- **Stored-Value Cards** - Since stored-value card are simply a technology used to implement a given fare policy, they will not affect the effectiveness of demand management. In fact, because of the superior information storage possible with stored-value cards, it may be possible to better enforce existing demand management techniques and design more effective techniques in the future.

4.3.1.2 Financial Criteria

Fare Revenue

Fare integration strategies can have an important impact on revenue, due to changes in fare and/or changes in ridership that can result. In addition, revenue loss from pricing integration is often an obstacle to fare integration and should therefore be considered explicitly in the analysis of integration strategies. These strategies will often

lead to increases in ridership combined with decreases in revenue per passenger, and the major issue is determining the net impact of these two changes on overall revenue (although there are other societal benefits resulting from increased ridership that are not captured by a strict financial analysis). If the impact of a strategy on ridership is known from previous modeling, this information can be combined with information about fare levels to analyze how fare revenue will change. If quantitative ridership information is not available, this analysis will rely more on the analyst's experience, knowledge, and ability to estimate the overall impact of different fare integration actions.

Performance of Fare Integration Strategies

- **Transfer Discounts** - It is generally assumed that transfer discounts will lead to decreased revenue, because the increased ridership rarely compensates for the decreased revenue per rider (although it is certainly possible to imagine situations where revenue would increase). This revenue loss is often a significant source of controversy, as is currently happening in New York City. However, if the other benefits of an integration strategy can be shown to make up for this revenue loss, then implementing that strategy is still worthwhile.

- **Period Passes** - Passes can also lead to significant revenue loss, depending on how they are priced with respect to the regular fare. Some systems, such as the STCUM and the MBTA (Boston) price their passes relatively cheaply compared to a single fare, which can lead to significant revenue loss because regular commuters receive a significant discount over the cost of paying in single fares. Other systems, such as the CTA (Chicago) and the TTC (Toronto) price their passes quite high, so that only very frequent users receive any significant discount. In additions, systems such as New York City Transit do not provide any pass, partly because of the concern about negative revenue impacts. Overall agencies can control the degree of revenue loss by choosing a certain pricing level, but this can diminish the positive impacts in other areas.

- **Stored-Value Cards** -By themselves, stored-value cards are unlikely to have a significant impact on revenue, because they do not imply any change in pricing

policy. If anything, cards can lead to increased revenue, because fare collection is more reliable and less dependent on human verification.

Revenue Allocation

This criterion is not included in Fleishman's report, because it is not of general concern outside of fare integration. Revenue allocation is necessary when fare integration is implemented between operators and leads to a situation where money that belongs to one operator is collected by another (such as with discounted transfers). This is particularly important when fare integration involves revenue loss, since this loss must also be distributed between operators. Reaching an agreement in this area will require significant work and potentially, financial sacrifice, and the real question is how the benefits produced by a fare integration strategy compare with the effort required to develop a revenue allocation agreement for that strategy. Because revenue allocation can be such a critical issue, it is important to consider it before moving to implementation, or else there may be problems at the point where a revenue allocation agreement must be developed. The Uniform Fare Structure Agreement in San Diego provides an example of a revenue allocation agreement that has survived for many years, with modifications negotiated as necessary to keep participants involved.

Perhaps the most important issue that will provide information about the difficulty of revenue allocation is the amount of revenue loss. If this loss is relatively small, then revenue allocation may not be a tremendous problem, whereas fare integration strategies that involve the allocation of a large amount of revenue loss among operators are likely to create a large amount of resistance. In addition, the ownership and regulatory status of the entities involved can provide some information about the difficulty of reaching an agreement. If the agencies involved are under the same ownership or are regulated by the same government, then the owner or regulator may be able to encourage all of the agencies to participate in a revenue allocation agreement (assuming that the owner / regulator is supportive of the integration strategy proposed). One can also look at the degree to which these agencies have been able to cooperate in the past, as a guide to how they may behave in the future. Overall, the analysis of revenue allocation depends on

understanding the agencies involved, and using that understanding to determine how difficult it will be to agree on a revenue allocation method for a given fare integration strategy.

Performance of Fare Integration Strategies

- **Transfer Discounts** - Transfer discounts create a definite revenue allocation problem, because when the transfer discount is sold by one operator to a passenger, some of the money from that sale is owed to the operator to which the passenger transfers. This allocation can be done based on information from the fare system (if available), or from separate surveys. Because transfer discounts can lead to significant revenue loss, developing an agreement for allocating the revenue can be quite difficult, even with perfect information. This problem has been part of the reason that free transfers between rail and bus in New York City have been stalled for so long, illustrating the problems that can be created by the need for a revenue allocation agreement.

- **Period Passes** - Period passes share many of the same revenue allocation problems as transfer discounts. Data can also be collected by the fare system (as done in Boston), or through passengers surveys (as done in Montreal). Because all the revenue is collected at central locations where passes are sold, developing a formula and agreement for allocating this revenue can be quite difficult, and can potentially make implementing inter-operator passes quite difficult (in Montreal, extensive negotiations were required before an agreement could be reached).

- **Stored-Value Cards** - Stored-value cards do not have the same revenue loss implications, but revenue allocation is crucial, because revenue is collected at central locations where fare media is sold. This necessitates the development of a revenue clearinghouse that can handle the process of distributing that revenue to all participating agencies. Fortunately, stored-value card systems provide a high level of information, so the information needed for revenue allocation is readily available, which makes revenue allocation relatively non-controversial for stored-value cards.

Fare Collection Costs

Fare integration strategies usually require capital investment and often lead to increased operating costs, making it important to consider the short- and long-term implementation costs in the evaluation of fare integration strategies. However, estimating these costs can be difficult, because each fare integration implementation is different from those that came before, in addition to which, manufacturers do not readily provide information about equipment costs unless they are making a sale. Fortunately, there are a number of reports available (including Fleishman's *TCRP Report 10*) which provide general cost estimates. These can be used to make predictions about the more obvious costs, such as equipment and fare media. It can be more difficult to estimate costs due to more subtle impacts, such as increased dwell time due to the complexity of a strategy and/or technology, or increased labor costs as drivers and station staff are asked to handle the additional complications of fare integration. However, it is important to take into account these less obvious costs, to identify strategies that may increase costs in the long-term, even if they seem reasonably inexpensive in the short-term.

Performance of Fare Integration Strategies

- **Transfer Discounts** - The initial cost of implementing transfer discounts can be quite low, particularly for a bus system where almost no equipment is needed for simple paper transfers (transfer issuing/vending machines are often installed at rail stations, although they are not necessary). For a simple paper transfer system, the major cost is in the media, because each transfer can only be used once (recycling is theoretically possible with magnetic transfers, but it is practically difficult). Even though the media cost only a few cents, this can build up over the course of a year if there is any significant level of transferring. Magnetically encoded transfers have basically the same problem, since they are slightly more expensive than paper transfers, and also require the installation of more expensive transfer issuing and accepting machinery on board vehicles and at stations (although they do have some cost advantages, such as data collection and automated acceptance at rail stations).

- **Period Passes** - Passes can be implemented relatively easily at low cost, using simple flash passes that are verified visually by drivers and station staff. The pass media itself usually costs less than 5¢, so the overall cost can be quite low, depending on how long the pass is valid. Passes can also use magnetic stripe cards as the medium, to provide superior data collection and allow for automated verification (this can significantly reduce passenger delay at rail stations). This requires the installation of card readers on board vehicles and/or at stations, which can be expensive (between $1200 and $2000, which is still cheaper than a transfer issuing and acceptance unit), in addition to the fact that the media is slightly more expensive. Overall, passes tend to be simple and inexpensive, but it is also possible to implement a pass system that is considerably more complicated and costly.

- **Stored-Value Cards** - Stored-value cards tend to have a fairly high initial cost, because read/write units must be installed at all locations where passengers are boarding. In addition, the fare media is initially expensive, particularly for smart cards, which currently cost between $2.50 and $7 each (magnetic stripe cards cost about 10¢). However, this is mitigated by the fact that they have a relatively long life, which leads to a competitive life-cycle cost (this is what allows smart cards to be competitive with other media). In general, stored-value cards have a high initial cost, but they can save money in the long-term, through longer life, improved data collection, greater automation, and reduced maintenance (particularly for smart cards).

Fare Abuse / Evasion

The existence of opportunities for fare abuse and evasion are principally a characteristic of the fare system, but the implementation of a fare integration strategy can lead to changes in the risk of abuse and evasion, through the introduction of new fare media and new payment methods. Although the impact of some strategies may be relatively minor, it should be given some consideration. The two areas that must be considered are opportunities for passengers to evade fare payment and the opportunities for drivers and other employees to steal revenue. The opportunities for this are wide-ranging, and it can be difficult to enumerate all the possibilities. In general, the analyst

should consider ways in which a rider could avoid making full payment for a ride, or where they might be able to ride multiple times for the price of a single ride. In terms of theft on the part of employees, the analyst should consider the entire path followed by fare media and revenue, to determine where opportunities for "leakage" might exist. Overall, there is no real methodology for analyzing fare abuse and evasion; it is more a matter of considering the integration strategies proposed and thinking about areas where abuse and evasion might occur.

Performance of Fare Integration Strategies

- **Transfer Discounts** - Transfer discounts provide the opportunity both for abuse by employees and for evasion by riders. The major problem often encountered with transfer discounts is enforcing the validity, in terms of time of use and subsequent travel allowed. The time information provided on transfers can be inaccurate, leading to conflict over the period during which they can be used. In addition, transfers usually restrict the subsequent travel that is possible (to avoid round-trips and stopovers), and passengers often attempt to circumvent these restrictions. In addition, at locations where transfers are available from a dispenser inside a paid area (this is common at rail stations), there are problems with users obtaining multiple transfers for use by other travelers. This problem can be overcome by not accepting transfers from a certain station for boarding at that station, or by issuing single transfers only at the time of payment. Many of these problems can be solved through the use of magnetic transfers, which can provide more reliable time and boarding information, to ease the enforcement of travel restrictions. In terms of employee abuse, the major problem is the theft of unused transfer media, which can then be sold for a profit. This is often combated by only having the transfers valid after they have been encoded mechanically, so that the basic media is worthless. Again, magnetic transfers provide a very attractive means of encoding this information at the time of issue (the use of magnetic encoding also makes it more difficult for fare evaders to self-encode the media).

- **Period Passes** - The major evasion problem with passes is use of a single pass by multiple riders. In many systems, this is explicitly forbidden, but almost impossible to enforce. The STCUM tried to control this problem for many years by requiring that users attach a picture to their pass, but in recent years they have given up on this and made it explicitly legal to transfer passes between different users. At locations where passes are verified automatically (such as magnetic readers on turnstiles), the magnetic code from the pass is usually stored in memory for some short period (usually about 30 minutes), to prevent two people from entering on the same pass. In terms of employees, these is some potential for theft of the passes themselves, but beyond this, they tend to be reasonably secure.
- **Stored-Value Cards** - Stored-value cards tend to be highly secure, because of the amount of information that can be stored on the card and the fact that a set amount is automatically deducted for each ride. In addition, since cards themselves have no value until money is encoded by the user, there is really no incentive for employee theft.

Prepayment

The degree of prepayment will be mainly a function of the overall fare system (as well as a host of other factors), not specific fare integration strategies. Since there is no reason to believe that specific fare integration strategies will impact the percentage of fares that are prepaid, this criterion is excluded from the remainder of the analysis.

Risk

Most of the marginal risk that might result from implementing a fare integration strategy is likely to be covered by other evaluation criteria like revenue and cost. Because this criterion is not likely to provide any information not covered elsewhere, it is eliminated from further analysis.

4.3.1.3 System Criteria

Operational Environment

This criterion is a combination of three criteria presented in Chapter Two: "Operational Impacts", "Compatibility with Other Assets", and "Ease of Implementation", which overlap to the point that little is gained by considering them separately. Fare integration strategies do not exist in a vacuum, and they must be compatible with existing operations. Considering how proposed strategies will interact with current operations will allow potential negative interactions to be identified and mitigated before the strategies are implemented. This criterion encompasses a wide range of potential impacts, because the operational environment can be very complicated. Issues that should be given some consideration include the impact on vehicle speed and boarding, the interaction with the system structure, and the physical modifications necessary to implement a certain strategy. It is also useful to think about how a proposed fare integration strategy will fit into current management practice and how employees and their union will react. In addition to the general areas suggested, each transit system will have a unique set of operational issues that should be recognized when analyzing each fare integration strategy.

Performance of Fare Integration Strategies

- **Transfer Discounts** - In terms of vehicle operations, transfer discounts can slow the boarding process when collected on board a vehicle, leading to increased dwell times, increased travel times, and therefore increased costs of vehicles and labor. In addition, transfers can also require the installation of new equipment, both on vehicles and in stations, and it is important to consider how this equipment will physically fit in these locations. There may also be problems with conflicts between riders and operators over validity, and these may in turn lead to labor problems. It is also useful to consider how the distribution and collection of the transfer media will take place, and how this will fit into the current revenue management process. Overall, transfer discounts shouldn't cause major problems in this area, but it is important to perform

some basic analysis to ensure that no major problems will be encountered at a later point.

- **Period Passes** - Passes can be made to fit quite easily into the operational environment, particularly if they are flash passes that don't require any equipment. One issue is the need to set up a distribution network, particularly for bus systems that do not have very many fixed locations at which to sell passes. Options for dealing with this included third-party sales (at newsstands and other stores), phone sales, mail sales, and distribution through employers. Otherwise, passes are relatively easy to deal with, since they have little impact on boarding and are relatively easy for operators to deal with. The only other major area of concern is the case where magnetically encoded passes are being used, in which case it is necessary to think about how the necessary equipment will be installed in vehicles and at stations.
- **Stored-Value Cards** - Stored-value cards require the installation of equipment on vehicles and at stations, and it is important to think about how this installation will take place. Another important element of stored-value cards is the need for a computer network to support the system and perform duties such as data collection, revenue allocation, and information processing. Stored-value cards may also cause problems with operator acceptance, as evidenced by problems experienced in Ventura County. Stored-value cards can require significant changes to the operations of a transit agency, and it is important to think about what these changes will be before moving towards implementation.

Management Information

The fare system can provide information about ridership and revenue, which can then be used to make decisions about revenue allocation. Because of the potential value of this information in fare integration, it is important to consider how much management information will be provided by the integration strategies being considered, to ensure that the information required for fare integration is available. The key element is to look at the management information that would be required for a certain fare integration strategies, and analyze whether that information will actually be made available by the

fare system. If this information is not available, then it is important to think about where that information might come from.

Performance of Fare Integration Strategies

- **Transfer Discounts** - Paper transfer discounts generally provide very little management information, since data collection is difficult. One could imagine having drivers keep track of transfers manually, or counting transfers received on each bus route (particularly if the transfers contain information about the originating bus route). However, performing the counts and analysis is labor intensive, and is unlikely to yield very reliable results. In this situation, supplementary ridership surveys will probably be necessary to obtain the information needed for revenue allocation. In the case where magnetically encoded transfers are used, this information can be gathered much more easily, particularly if all transfers are verified electronically. Although some additional surveys may be required if there are gaps in information, magnetic transfers should provide much of the information that is required.

- **Period Passes** - Similar to transfer discounts, the amount of management information provided by passes is mainly dependent on whether they are verified manually or electronically. Although some agencies attempt to have drivers input pass boardings manually into electronic fareboxes, it is not clear that this will yield accurate results. In the case where passes are verified magnetically, this should provide the required information, although it is important to ensure that some accounting procedure is available for times where the verification equipment malfunctions or passengers' passes become demagnetized.

- **Stored-Value Cards** - One of the most attractive features of stored-value cards is that they provide a wealth of ridership information. Both magnetic-stripe cards and smart cards should provide the information needed for fare integration, so both types of cards will perform well according to this criterion.

Ability to Integrate Modes

This criterion should clearly not be included in a specific analysis of fare integration, since it is intended for use in a general situation when an entire fare system is being evaluated. In the context of specifically evaluating fare integration, it is too all-encompassing to provide useful information.

Marketing Support

Many transit agencies are beginning to take marketing more seriously, and fare integration can be an important marketing element, because it can make transit more attractive, to both current and potential users. The importance of this criterion would depend on the importance of marketing to the agency performing the analysis, but it should be given some consideration. As agencies gain more experience with marketing, they will be able to see how they can use the fare system and the accompanying fare integration strategies to support their existing marketing efforts and develop new marketing techniques.

Performance of Fare Integration Strategies

- **Transfer Discounts** - Transfer discounts do not provide very much marketing support, because they are very simple and not very flashy. The provision of free or discounted transfers can be used as an inducement to use the system (particularly if it is possible to make stopovers or round-trips). However, it is unlikely transfer discounts project a strong enough message to make them an effective marketing tool.
- **Period Passes** - Passes can add significantly to the attractiveness of public transit. London Transport feels that their Travelcards provide a transportation benefit similar to the car, where the initial cost is high, but the incremental cost of travel is close to zero, thereby encouraging increased travel by transit. The availability of a range of passes is also a positive marketing element, because it makes the benefits of passes available to a wide variety of users, including tourists, occasional users, and daily commuters. In general, passes can be an important marketing element, because they

make public transit convenient and simple, and generally provide a discount over single fares.

- **Stored-Value Cards** - Stored-value cards can provide a significant marketing benefit, because of the perception of sophisticated technology, which can serve to make the transit system more attractive, and potentially attract new riders. In addition, if transit becomes part of a wider smart card network, this will increase the base of people who can easily use public transit. Smart cards also provide the intelligence necessary to implement sophisticated marketing techniques, such as bulk discounts and discounts for joint purchases. In general, the flexibility provided by stored-value cards (and particularly by smart cards) can be used to implement innovative marketing programs.

Range of Options

The range of options available is a characteristic of the fare system, not of fare integration actions. Although fare integration may increase the range of options, this is an impact that needs to be analyzed in the context of the entire fare system, not at the level of the specific action being considered. This criterion is therefore excluded from further consideration for evaluating fare integration.

4.3.2 External Criteria

Equity

Because of the pricing changes created by many fare integration strategies, equity issues can be important and should be considered explicitly in the evaluation. For example, there is some debate on the equity of transfer discounts, because it is unclear whether people who transfer are in fact taking longer trips, making it acceptable to charge them twice. However, the analysis of equity impacts is complicated by the debate over the definition (as discussed earlier). In the area of fare policy, equity is related to fare structure and pricing, since different pricing structures lead to different levels of equity depending on the characteristics of the riders and urban area. Issues that need to be considered include the distribution of income throughout the region, the distribution of transit trips throughout the region (and the interaction between these two areas), and the

access that users have to the transit system and the fare integration strategies being implemented.

Performance of Fare Integration Strategies

- **Transfer Discounts** - The impact of transfer discounts on equity depends on the distribution of trips by income. If lower income riders tend to make longer trips, then transfer discounts should serve to increase equity, because they will help to reduce the costs for those riders. However, if higher income riders tend to make longer trips, then transfer discounts will lead to reduced equity, since this will provide a discount mainly to those who are already better off. In general, if the discounts provide greater benefit to the lower income users as compared to higher income users, the equity impact should be positive.

- **Period Passes** - The equity impact of passes depends on the periods of validity that are available. If passes are only available in longer periods (such as a month), then this can create an inequity for lower income riders, who may not be in a position to make the necessary lump payment to buy the pass. The use of shorter duration passes, such as daily, weekly, or biweekly, can help to alleviate these concerns (although shorter duration passes tend to provide a smaller discount than longer duration passes). In addition, if passes are not easily available throughout the service area, this can create inequity based on location and other factors (for a time, the MBTA in Boston only sold passes through employers, which denied this potential benefit to people who's employer did not participate).

- **Stored-Value Cards** - Since stored-value cards are generally used to implement a given fare structure, their impact on equity may not be large. However, it is important to look at the access that users will have to technology. In the case of smart cards, some agencies have discussed the possibility of requiring the payment of a refundable deposit on the card at the time of purchase, or only allowing smart cards to be sold in higher denominations. As with the initial payment required for a pass, this initial payment may constitute a barrier to smart card use by lower income riders. Another important issue for both types of stored-value cards is access to purchase and recharge

locations. For rail systems, the most logical location for vending machines is at rail stations. But for a user who does not ride the rail system, this can be problematic if they don't regularly use rail. Similar problems are encountered if the agency operates only buses, and therefore has to set up special locations for recharge, which may not be evenly spread through the service area. Solutions to this problem include remote reloading over the phone (although this requires access to a phone and a credit card), the creation of large number of sales locations, or setting up vending locations in stores (this is what is planned in London, even though the rail system provides good coverage). Because of the technology involved in stored-value cards, the equity of access to this technology can potentially become an important issue.

Convenience / Complexity

For analyzing fare integration strategies, convenience and complexity are combined into a single criterion. Although they are separate issues, they are closely related, and it is difficult to consider one without getting involved in issues related to the other, so combining them will avoid the need to repeat portions of the analysis. Clearly, fare integration strategies can have an impact in both areas, making it important to consider them when analyzing potential strategies. For considering convenience, issues that include the degree of exact change use (leading to increased inconvenience), and the compatibility of a fare integration strategy with other payment technologies in place. In terms of complexity, important issues include how difficult the fare structure (pricing) is to understand, and whether the technology creates a barrier to use by adding another level of complication. In both area, it is important to consider the impacts on frequent, irregular, and new users, who will often react differently to a certain fare integration strategy.

Performance of Fare Integration Strategies

- **Transfer Discounts** - Transfer discounts do not have a very important impact in this area, because they are reasonably simple and do not really create any increased convenience. There is some small increase in convenience because users do not have to produce exact change for the second mode boarded, but the major impact is

financial. In terms of complexity, transfer discounts do require that the rider understand that they need to pay extra for the transfer and then do not pay for the next ride, but this is likely to present an obstacle only to users who are complete novices.

- **Period Passes** - Passes definitely creates increased convenience, because they provide a single payment medium for the entire period of validity, so that users don't have to worry about paying single fares. In addition, users can board any vehicle on which the pass is valid, making it easier for them to make shorter trips or use public transit to get to an area where they might normally drive. In terms of complexity, passes are quite simple to understand, and they are unlikely to present a major obstacle in the decision-making process.

- **Stored-Value Cards** - One of the main benefits of stored-value cards is increased convenience, because they provide a single fare medium that can potentially be used on a variety of different modes and operators. However, the implementation of fare integration strategies using stored-value cards can increase complexity, because of the need to understand how the stored-value cards work. Although these cards can be implemented in a way that they are very simple to understand, it is also possible to do it in a way that significantly increases the complexity of the fare system. Riders in New York City have had a number of problems adjusting to the use of the Metrocard, while most users in Ventura County have accepted smart cards relatively easily. Based on this experience, it appears that careful thought must be given to the complexity of stored-value card implementation, to ensure that the system is reasonably transparent.

Acceptability

As with convenience and complexity, political and public acceptability have been combined into a single criterion. These are clearly highly inter-related, but separate issues, so combining them should help to simplify the analysis without major loss of information. Because fare integration strategies are implemented in a highly public environment where both politicians and the public at large provide substantial input, it is important to consider the acceptability of a strategy before implementation, since it will

surely become an issue after implementation. Analyzing this acceptability depends on having a strong understanding of the political, economic, and social factors that are important to the public at large and the politicians that represent them. Techniques such as focus groups, polls, and surveys can be used to analyze acceptability, but it is also important for the analyst to have a good grasp of the critical factors to make a determination on this criteria.

Performance of Fare Integration Strategies

- **Transfer Discounts** - The major issue with transfer discounts is the revenue loss, which can create both political and popular opposition. Although the revenue lost by the public transit agency is kept by the users, if this revenue loss will be made up from taxes that are paid by both transit users and non-users, this can lead to problems. This amounts to an income redistribution, which could lead to opposition from non-users. Issues of this type held up the implementation of transfer discounts in New York City, although these issues now appear to have been resolved. If the revenue loss can be made up from within the agency (by creating cost savings in other areas), this will help to eliminate much of this opposition.

- **Period Passes** - As with transfer discounts, the major source of opposition to passes will be the revenue loss due to people who use the pass very frequently. This problem has created political opposition in Chicago, leading to responses such as the elimination of the pass and users being charged a small incremental fare each time they ride (combined with a lower initial pass cost). In addition, issues related to equity can create objections to the initial cost of passes, as described earlier. Overall, passes should not create major opposition, but it is important to price them at a point which is consistent with the perceived role of public transportation (in Montreal, pass are priced low, partly because public transportation is seen as an important government service, while passes in Chicago are priced much higher, because the government wishes to limit its subsidy).

- **Stored-Value Cards** - Stored-value card can be quite attractive to both the public and politicians, because of the perception of sophistication that accompanies them. Riders

will want to see stored-value cards implemented because of the convenience benefits that they perceive, while politicians will want to be associated with the high technology image that they project. However, the increased complexity that results from stored-value cards may lead to acceptance problems, as users become worried about issues such as lost cards, refunds on remaining balance, and privacy. In addition, the initial capital cost of implementing stored-value cards can also create opposition. One interesting example of the acceptability of stored-value cards is New York City, where the promise to implement the Metrocard was used to leverage money for the entire multi-billion dollar capital plan. This illustrates the attraction of stored-value cards, and indicates that if they are marketed properly to politicians and the public, acceptability should not be a problem.

4.4 Summary of Evaluation Criteria

Table 4-2 summarizes the proposed evaluation criteria and the performance of the three major fare integration tools according to each criterion.

Criteria		Transfer Discounts	Period Passes	Stored-Value Cards
Usage Criteria	Ridership	+	+	o
	Demand Management	-	--	+
Financial Criteria	Fare Revenue	-	--	o
	Revenue Allocation	-	-	++
	Fare Collection Cost	-	o	-
	Fare Abuse / Evasion	-	-	+
System Criteria	Operational Environment	o	+	-
	Management Information	-	-	++
	Marketing Support	o	+	++
External Criteria	Equity	++	+	-
	Convenience / Complexity	+	+	++
	Acceptability	o	+	o

Table 4-6: Summary of Evaluation Criteria and Performance of Fare Integration

5. The San Juan Context

The San Juan Metropolitan Area (SJMA) is located on the north coast of the island of Puerto Rico, and had a 1990 population of 1.3 million people. The SJMA is made up of 13 municipalities and occupies 400 square miles of land, one-third of which (135 square miles) is urbanized. The Atlantic Ocean to the north and the volcanic mountains to the south are the major physical barriers that have influenced the area's development [51]. From the original north-south spine made up of the older urban centers of Old San Juan, Santurce, Hato Rey, and Río Piedras, development has spread along an east-west axis into Carolina (east), Bayamón (west), and beyond. These physical constraints and linear development patterns have led to population densities that are among the highest in the United States. In addition, car ownership in the SJMA has increased rapidly over the past three decades, from 0.141 cars per person in 1964 to 0.405 cars per person in 1990 [51]. This increase in car ownership, combined with a deteriorating public transit system, has led to sharp declines in alternative mode commuting, with more than 90% of all work trips made by car in 1990. This has resulted in increased roadway congestion, with over 50% of 1990 total inbound direction lane mileage being congested in the morning [51].

5.1 Current Public Transportation System

Currently, public transportation in the San Juan Metropolitan Area is provided by three major modes:

5.1.1 Fixed-Route Bus

Fixed-route bus service is currently operated in two major ways; publicly run service operated by the Metropolitan Bus Authority, known by its Spanish acronym AMA (Autoridad Metropolitana de Autobuses), and services contracted by the Puerto Rico Highway and Transportation Authority, known as ACT (Autoridad de Carreteras y Transportes).

As of 1995, AMA operated 43 routes in the central part of the SJMA, using 159 full-sized buses. Headways on the different routes varied between 15 and more than 75 minutes, with very few routes under 30 minutes. Although new equipment purchases and system changes have led to service improvements in recent years, the AMA system is generally seen as unreliable and inefficient and is rarely used by anyone who has a good choice of transportation modes. Current fare on AMA is 25¢, with no tickets, transfers, passes, or other specialized fare media in use [51].

The service contracted by ACT, known as Metrobus, currently consists of two routes that serve high demand corridors with frequent, reliable service. Metrobus Route 1 operates mainly on a reserved, contraflow bus lane along the heaviest travel corridor in the region (Rio Piedras - Hato Rey - Santurce - Old San Juan). This service is run by a private company, with a headway of 4-5 minutes during the peak period. Metrobus II operates partially in the same corridor, but branches off to run to Bayamón, an important urban node located in the western part of the SJMA. Interestingly, Metrobus II is operated by AMA, but under separate contract to ACT, not as part of its general bus service. Both services have experienced considerable success since their introduction, with improved performance leading to increased ridership as compared to the previous AMA service. Fare on both routes is 50¢, and again, no specialized fare media are currently in use [51].

In addition to these public services, there are a few privately operated bus services, but these are fairly marginal operations using older equipment.

5.1.2 Jitney

Regulated, privately-operated jitneys, known as públicos, are currently an important public transit mode in the SJMA, carrying the largest share of transit passengers. Públicos are loosely regulated by the Public Service Commission (PSC), which exercises some control over routes, fares, and market entry. Públicos provide service throughout the SJMA as well as to all other areas of Puerto Rico. Vehicles tend to be individually owned and operated, with many drivers grouped into so-called terminal associations (made up of drivers who serve a major terminal) that undertake government

lobbying efforts, jointly purchase parts for members, and perform other activities on behalf of their members. Although service is sometimes loosely scheduled, públicos generally operate as a demand responsive service, with frequencies varying from 30 to under 1 per hour. Fares are generally based on distance, and are collected directly by the driver. In 1995, there were on the order of 120 local routes in service in the SJMA, with the majority operating into terminals in Rio Piedras and Bayamón [51]. While the públicos receive no direct government subsidy, the government has constructed terminal and garage facilities for general use by drivers. Although they are an important part of the public transit system, públicos are in decline, and their future remains a large and important question mark in the SJMA transportation system [51].

5.1.3 Ferry

The Puerto Rico Ports Authority currently operates a three-terminal ferry system, known as Acuaexpreso, which provides service between Old San Juan, Cataño (across the bay from Old San Juan), and the Hato Rey business district. This service is competitive with buses in the Old San Juan - Hato Rey market, and is the only direct service in the Cataño - Old San Juan market. Patronage on the service has been generally poor in recent years, particularly to the Hato Rey terminal. The fare is 75¢ for the Old San Juan -Hato Rey route and 50¢ for the Old San Juan - Cataño route, with fares collected by agents at the terminals. The future of the system is unclear, although the level of initial investment will probably guarantee continued operation for the near future.

In addition to the modes described above, AMA also operates a handicap-accessible paratransit service, using a fleet of 15 (soon to be expanded to 30) lift-equipped vehicles.

Figure 5-1 shows the trend in bus and público market share over the past three decades (Metrobus and the current Acuaexpreso service were not operating in 1990):

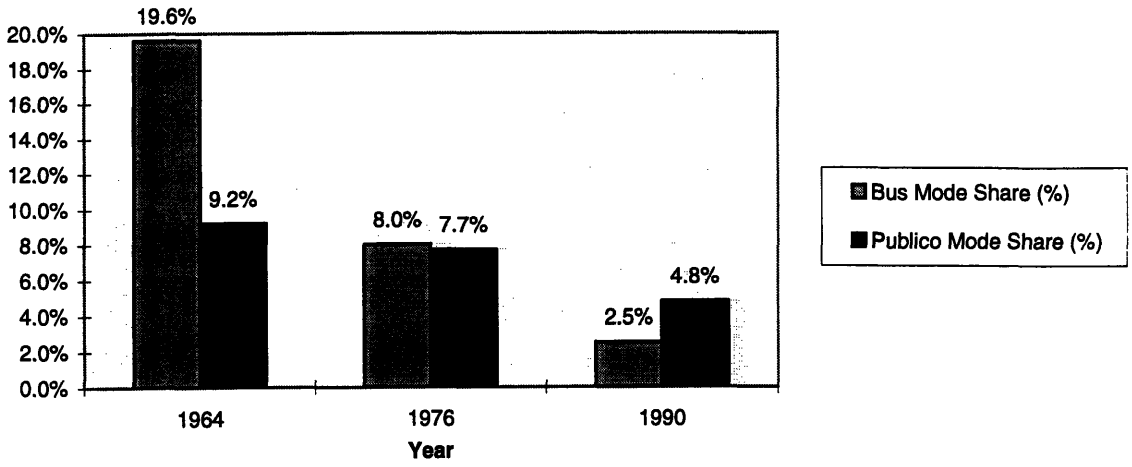

Figure 5-1: Mode Share for Bus and Público

5.2 Current and Future System Changes

A number of changes to the public transit system are currently planned or are in the process of being implemented, with the general goals of improving service and providing better regional connectivity. The two major elements of these changes are a reorganization of the bus and público network into a transit center based system, and the construction of the Tren Urbano rapid transit line.

5.2.1 Transit Center System

As described earlier, and as evidenced by the changes in mode share over time, both the públicos and the current bus system are in a state of long-term decline. Although the bus service generally provides good coverage and connectivity, as well as low fares, service is infrequent, indirect, and unreliable. To attempt to overcome these problems, an outside consultant has suggested a change from the current indirect, one-seat ride service to a multi-hub, transit center-based network, in keeping with the multi-nucleated urban form of the San Juan area.

Under the Transit Center system plan, bus service will be reorganized from its current direct service to focus on a number of transfer points located throughout the region. Frequent service will be provided between these nodes, with feeder service from the surrounding areas providing local service to the nodes—similar to the hub-and-spoke

network structure adopted by many US airlines since their deregulation. By feeding passengers into these transfer centers, frequent service between them can be justified on the basis of ridership. This system will require a large increase in the number of trips involving transfers (which is currently about 6% of all public transit trips), because there will be many fewer origin-destination pairs that will be served by a one-seat ride. However, this new system structure should reduce overall travel time, increase the reliability and attractiveness of service, and make it easier to get around the region by public transit. Although some riders may be negatively affected by the system reorganization, far more should benefit from the increased connectivity and improved frequencies.

In addition to reorganizing the bus network, the Transit Center plan also proposes integrating a number of key público routes with the bus services at the transit centers. Many of the proposed transit centers are located at or close to the existing público terminals, so this should help to increase the integration between bus and públicos, potentially allowing públicos to serve as an additional feeder system to the trunk bus routes.

The Transit Center plan is currently in the process of initial implementation. Because of the broad scope of the changes to the network structure, the plan is being phased in over a period of years. Some of the transit centers are currently in operation, others are under construction, while others will be built as part of Tren Urbano stations. Bus route reorganization is also proceeding slowly, to coincide with the opening of new transit centers, the implementation of new Metrobus routes, and the delivery of new vehicles. Given the historically negative image of the bus system, the transit center plan is being used as an opportunity to modernize and improve all aspects of the service, so that the bus system (and to some extent, the público system) will be ready to serve as a feeder network to Tren Urbano.

5.2.2 Tren Urbano

The most important public transit project in San Juan is the Tren Urbano heavy rail rapid transit line that is currently beginning construction. The Phase I alignment of

the project runs from the business and residential district of Bayamón in the southwest, through the Medical Center (Centro Medico), the university district of Rio Piedras, and the business center of Hato Rey, to Santurce in the north. By providing a high quality, grade-separated service, Tren Urbano should help to mitigate existing congestion in this corridor, while improving public transit service and increasing mobility. Particularly in the corridor between Rio Piedras and Santurce, which is currently very congested, Tren Urbano should provide a superior level of service and attract new riders to public transit.

Tren Urbano is being built using a turnkey design-build-operate-transfer procurement. A multi-national consortium is responsible for all cars, electrical, signal, and track work, as well as the yards and shops and a portion of the alignment construction. To facilitate technology transfer to Puerto Rico, the remainder of the alignment will be built by other contractors in small segments. The use of this innovative procurement strategy is expected to reduce costs somewhat, speed construction, and ensure high-quality operations in the future. For the purposes of this research, it is important to note that the Tren Urbano fare collection system was not specified in the original turnkey contract, and was left for later determination by the government and the turnkey consortium.

As part of the Tren Urbano project (and the continued implementation of the Transit Center plan), it is planned that existing and new bus and público routes will be re-oriented to serve as a feeder system to the rail line. By the year 2010, it is expected that over 50% of Tren Urbano riders will access their station by transferring from another public transit vehicle. This indicates the importance of this feeder system to the overall ridership goals: clearly, continued support of the bus and público system is crucial to the success of the public transit system as a whole.

5.2.3 Timeline

As discussed in the analytical framework, an important element of the fare integration decision-making process is the timeline on which changes are taking place, which provides part of the context for these decisions. In San Juan, there are three major decision points in the implementation of the Transit Center plan and Tren Urbano, and it

is important to focus on these throughout this analysis. By the end of 1997, the first step of the bus and público reorganization plan is expected to be complete, with a number of transit centers in place and bus routes and públicos services partially re-oriented to serve these nodes. In late 2001, the first phase of the Tren Urbano system will open, which will create further changes in the system as buses and públicos are re-oriented to serve the major stations. At some point in between (most likely sometime in 1999), a second step in the bus and público reorganization will be put into place, involving further re-routing of service as well as a likely fare increase. In addition, basic decisions about the Tren Urbano fare system are currently being made, but it is unclear at this point what their results will be. Decisions about fare integration must be made within this timeline, targeting these decision points as times when fare integration implementation is most likely.

5.3 Motivation for Fare Integration

As discussed in the Chapter One, there are two major ways in which fare integration can create benefits: integration of fare technology and integration of pricing. Consideration of these two areas in the context of the current and future public transportation system in the San Juan Metropolitan Area makes it clear why fare integration should be pursued in San Juan.

The first aspect of fare integration, integration of fare media and technology to improve convenience and ease of use, is potentially very important in San Juan given the current fare technology (or lack thereof). As mentioned earlier, all public transit modes in San Juan operate on a cash only fare system, with no tickets, tokens, or passes. The implementation of Tren Urbano provides a somewhat unique opportunity to introduce new, more sophisticated fare technologies. These have the potential both to increase convenience for the user, by giving them more fare options and making it easier to move between vehicles, and to improve operations for the agencies, by improving revenue accounting and providing a rich source of data.

It is, however, in the second aspect, pricing integration, that the impact of fare integration is likely to be greatest. As discussed earlier, the current bus and público

system is based heavily on one-seat rides, with passengers reluctant to transfer between vehicles because of service unreliability. However, the changes resulting from the Transit Center plan and the creation of the Tren Urbano feeder system will significantly increase the need for transferring at the newly created nodes . For current users, this will mean that trips that are now one-seat rides will require one or possibly two transfers. If this increase in required transfers takes place without any pricing integration, it is likely to affect riders negatively. It is certainly likely to be viewed negatively by the public; although users have shown themselves quite willing to pay double price for Metrobus service, this may be contingent on the higher quality of that service. Moreover, the greatest negative impact will be experienced by lower income riders who may have little choice about their travel mode. Therefore, it is important to at least consider integrating pricing in conjunction with these planned service changes, particularly if stabilizing and increasing ridership is an important goal.

5.4 Characteristics of San Juan with Respect to Fare Integration

Although fare integration appears to be a reasonable action is San Juan, it is important to carefully analyze the impacts of potential fare integration strategies before proceeding with implementation. Although the evaluation methodology described earlier will be useful in determining the ridership and revenue impacts of different fare integration actions, it is also important to look at some of the more qualitative impacts of fare integration. To do this, it is necessary to analyze the particular characteristics of the San Juan area, with the goal of understanding how these will affect the implementation of different fare integration strategies. Although in many ways San Juan is not unusual, it does have some unique characteristics that present particular obstacles and opportunities with respect to fare integration. Economic, political, regulatory, and social issues are seen in different ways in San Juan than in most localities where fare integration has been implemented in the past, and this may significantly influence many aspects of transportation policy and infrastructure. Taking into account these unique characteristics will make it possible to design and implement fare integration strategies that will create more general benefit and work effectively in these specific circumstances.

For the purposes of this research, these characteristics have been divided into four major categories:

- **Institutional Characteristics**, related to the institutions and linkages that exist in the SJMA;
- **Service Characteristics**, related to the current and future public transportation services in the SJMA;
- **Social Characteristics**, related to the social and economic conditions in the SJMA; and
- **Technological Characteristics**, related to the technologies currently in use in the SJMA, as well as potential new technologies.

Each of these areas is broken down into specific characteristics that affect the implementation of fare integration in the San Juan Metropolitan Area.

5.4.1 Institutional Characteristics

5.4.1.1 Complex Operating Environment

As described previously, the public transportation services in the San Juan area that would be encompassed by a fare integration policy are operated by a number of different entities. Public operators such as AMA and the Port Authority will have to work with private entities, such as the Metrobus contractor and the estimated 3,000 público owner/operators, even without considering the various private contractors involved in building and operating Tren Urbano.

This complex multi-operator environment will add an extra layer of complication to the entire process of designing and implementing fare integration. Since these various operators will have different goals and philosophies, getting them to agree to specific fare integration strategies will be difficult. Reaching an acceptable fare integration solutions in a single-operator environment is hard enough; doing so in an environment involving this number and mix of operators will be considerably more difficult. It is therefore

critical to take into account this environment and the constraints that it will put on the development of an integrated fare policy.

5.4.1.2 Complex Regulatory Structure

In addition to the complex operating environment, the regulatory structure is also quite convoluted. AMA is regulated by the Department of Transportation and Public Works (Departamento de Transportacíon y Obras Públicas, or DTOP), which also regulates the Highway and Transportation Authority (ACT). ACT in turn regulates the Metrobus service (which is partially run by AMA) and controls the construction and future operation of Tren Urbano. Added to this is the PSC, which regulates the públicos to some degree, and the Ports Authority, which is directly responsible for Acuaexpreso service.

Because of this complex regulatory environment, developing agreement on, and participation in, a fare integration plan will be quite difficult. Because there is no single entity with power over all these agencies (aside from the central government), it is likely to be difficult to ensure cooperation from all players. Although integration should ideally be a voluntary decision on the part of the operators, experience has shown that it is often necessary for a central power to step in and exercise enough control to get all entities involved. Although DTOP might be able to get all of its agencies in line, the PSC and Port Authority may have little reason to participate. In the case of the PSC, there is even some question as to their ability to effectively control the público operators, given the limited scope of their regulatory powers. This complex environment is by no means intractable, but it is crucial to understand the dynamics of the power structure in order to ensure participation by as many players as possible.

5.4.1.3 Difficulty in Revenue Allocation

In any implementation of fare integration, there will be a need to allocate revenue among the different operators. Since riders will often pay for a trip entirely on one vehicle (or at one location), and then travel using other vehicles, it will be necessary to redistribute that money based on some agreed-upon calculation. The two main issues

involved are deciding how much each operator is owed and then actually distributing that money. While these issues should not constitute a problem for the bus and rapid transit systems, the públicos present a unique obstacle to revenue allocation, because the drivers depend on their daily income to pay their expenses for the next day. In terms of deciding how much each operator is owed, it is important to realize that the individual público drivers will not be willing to accept any revenue loss as a result of fare integration. The public sector will therefore need to be prepared to accept some amount of additional revenue loss if the públicos are to be included in fare integration.. In terms of physical distribution of the revenue owed to the públicos, drivers will want to receive their revenue as quickly as possible, and they are unlikely to endure the delay imposed by monthly or quarterly reimbursement (which is more standard for traditional systems).

5.4.2 System Characteristics

5.4.2.1 The Público System

Perhaps the strongest distinguishing characteristic of the public transit system in San Juan is the público system, which currently carries the majority of public transit riders in the area. Because of long-term declines in ridership, the público system is under-capitalized, leading to old, uncomfortable, poorly-maintained vehicles. The públicos are lightly regulated by the PSC, but receive no government assistance aside from the use of the common terminals that have been built in the past.

The inclusion of the público system will substantially increase the complexity of any fare integration plan that is proposed. Because the públicos are a fairly informal system, attempting to bring them into any type of formal fare policy arrangement will be difficult. At the heart of the problem is the fact that the público drivers are self-employed, rather than being employed by an organization that pays them a wage. This means that they are directly concerned with the fares that they collect and the cash flow of the service that they provide. Although this direct relationship between passengers and revenue can have many advantages from competitive and service quality points of view, it makes integration much more difficult. As a result, it would be tempting to completely exclude the públicos from any fare integration plan; however, their importance in the San

Juan public transit system (as evidenced by their 65% share of the public transit market), means that they must be included if integration is to be effective.

5.4.2.2 System Structure

In San Juan, the current fare structure is very simple, with a flat fare and no transfer privileges. In addition, the system structure strongly discourages transferring, with most trips being one-seat rides. Because of this, there is relatively little experience with transferring, since it is expensive (relative to a single ride) and unreliable. However, changes in the future will create a substantial need for transferring, because of the changes to the bus and público system and the construction of Tren Urbano.

Since customers have so little transferring experience, this increase will come as a shock, because of the increased price and inconvenience. Since fare integration can have a positive impact in both areas, this provides a unique opportunity to implement fare integration as a means of mitigating the negative impacts from system changes. Although there may be some acceptance problems due to a lack of previous fare integration, the system changes will create a strong impetus for users to take advantage of any fare integration strategies that are offered.

5.4.3 Social Characteristics

5.4.3.1 Income

Relative to many metropolitan areas in North America and Europe (where much of the previous research on fare integration has been done), per capita income in Puerto Rico is quite low. This is evidenced in the low public transit fares as well as in the low incomes that público drivers live on. Unfortunately, many of the fare integration strategies in place elsewhere in the world are in areas where average income is higher. This will mean that fare integration strategies used elsewhere will have to be examined closely to ensure that they are applicable in the different environment that exists in San Juan. This relatively low income will also limit the use of any fare integration strategies that rely on a higher base fare while providing a low-cost transfer option. Other options, such as distance pricing, can be considered more equitable in certain ways, but will be

unpopular compared with the current low base fare. In addition, the income distribution in San Juan requires lower income users (who are the main public transit users) to make a significant number of long trips. The planned system changes will double and triple the price of many of these trips, further supporting the importance of fare integration as a means of mitigating this negative impact.

5.4.3.2 System Perception

Users of public transit in San Juan have a fairly negative view of public transit. While this is not unique to San Juan, the level of service is poor enough that public transit is mainly viewed as an option that is acceptable only for people with no other choice (captive riders). Recent improvements in service may change this attitude somewhat, but this is a powerful perception that must be overcome if the system's decline is to be reversed. There are also real and perceived safety problems associated with certain areas of San Juan, which are projected onto the public transit services in those areas.

5.4.3.3 Lack of Transferring Experience Among Users

With only 6% of trips currently involving a transfer, gaining user acceptance of transfers may be difficult. Even developing a consensus that fare integration is needed may be hard, setting aside the more arduous process of actually implementing changes to the fare policy and structure.

To gain acceptance for transferring, it is important to clearly demonstrate the benefits that will arise and relate these to the planned changes in the system structure. Furthermore, any fare integration strategies that are introduced should be easy to use and transparent to the user, allowing them to change vehicles and modes with a minimum of confusion and delay. By increasing the positive impact and decreasing the negative impact, it should be possible to move towards greater acceptance of transferring.

5.4.4 Technological Characteristics

5.4.4.1 Acceptance of New Technology

In some respects, San Juan has demonstrated good acceptance of new technology, with a proliferation of pagers and cellular telephones. At the same time, however, other areas of technology have not been accepted nearly as well, particularly among lower income classes, who are the people who tend to use public transit. Many new fare technologies have been developed in recent years that can ease fare integration, making revenue allocation and fare collection much easier and more efficient. Given the inconsistent acceptance of new technology in San Juan, however, it may not be feasible to implement some of these new technologies. This problem is exacerbated by the fact that the current fare technology in San Juan is quite unsophisticated, making any change to newer technology potentially more shocking. From the operator's perspective, new technology means new investment, in terms of money, time, and effort. This may not be a great obstacle for the publicly subsidized modes, but it is likely to represent a significant difficulty for the públicos. Implementing high technology solutions in San Juan will involve walking a fine line between the benefits that can be realized from the technology and the obstacles that exist to its use and acceptance.

5.4.4.2 Difficulty in Creating Necessary Network

To implement a fare integration strategy, it is necessary to have a network, both physical and institutional, to mediate communications between the various parties involved. In its most basic form, this could involving setting up some sort of joint committee to develop, implement, and monitor the fare integration scheme. In addition, a system is needed to allocate and distribute revenue and fare media and coordinate the various machines involved. In a more complicated system, an electronic communication network would be needed to keep track of transactions and revenue to ensure that funds are tracked and distributed properly.

In terms of the institutional network, San Juan presents numerous problems due to the complicated nature of the operating and regulatory bodies. Getting all these stakeholders at the same table may be difficult, and maintaining that institutional contact

will be harder still. The público route associations may be able to play an important role by representing the interests of the público drivers in this process. In the case of the physical network, developing the necessary communications network may be difficult, both because of the multiplicity of operators and regulators and because of the spread-out nature of the vehicles and operations. In a traditional bus system, information can be downloaded from buses on a nightly basis, but this may be difficult with numerous small público operators.

5.4.4.3 Potential for Abuse

In any fare integration agreement, there is a potential for revenue abuse and fraud, both by the agencies involved and by the personnel. Since fare integration arrangements are fairly complicated, it can be difficult to keep track of all the elements with precision, which can facilitate fraud or theft. This can be a problem even in a highly regulated public monopoly with well paid, salaried employees. In San Juan, with independent and weakly regulated operators who depend solely on their farebox revenues for their income, the incentive and potential for fraud and theft is considerably greater. In addition, there is a potential for each of the entities involved to justify their own abuse by claiming abuse by other, which can lead to rapid deterioration of a fare integration strategy.

This means that any fare integration system must have a strong security element to monitor outgoing media and incoming revenue. Electronic fareboxes, automatic counting machines, and sophisticated fare media can all be used to mitigate this problem. It is also possible to design a fare integration plan so that it minimizes the incentive and opportunity for fraud and theft. This is an important concern that must be taken into account in all stages of design, implementation, and management of a fare integration strategy.

5.5 Conclusion

As described in this chapter, the public transit system in San Juan is currently undergoing major changes aimed at creating an improved system that can serve the area into the 21st century. Fare integration can be an important part of creating this system,

because of the general need for improved integration and the need to provide some financial relief as transit fares increase. However, it is important to think carefully about fare integration before implementation, to ensure that the strategies proposed will be effective. In addition, the San Juan area presents a number of special characteristics that must be taken into account (both explicitly and implicitly) during the strategy development process. The next chapter will analyze fare integration in San Juan, taking into account general principles related to fare integration, specific experience in other areas, and the specific characteristics of the San Juan area.

6. Analysis of San Juan Metropolitan Area

As described in Chapter Five, the San Juan Metropolitan Area is preparing for major changes to its public transportation infrastructure: the construction of the Tren Urbano rapid transit line and changes to the bus and público systems. Tren Urbano will form the backbone of the revamped transit system, running in two major corridors where travel is currently difficult due to traffic congestion and missing connections. Certain bus routes will also become high-frequency line-haul services of the same type as Metrobus 1 and 2, providing high-quality service between Transit Centers and to Tren Urbano stations. The remaining bus routes and the público system will also provide service to the Transit Centers and Tren Urbano stations, feeding many of the riders who will be carried by the line-haul bus and rapid transit lines. As these changes take place, it is crucial that integration between these services improve in all respects, and that the existing services be well integrated with Tren Urbano. As shown in Tables 6-1 and 6-2, which show predicted access to Tren Urbano in absolute and percentage terms [51], Tren Urbano will depend heavily on the modes currently in operation to bring passengers to its stations. Without effective integration, it will be difficult for Tren Urbano to achieve the ridership levels that are predicted, and the success of the entire system may be jeopardized.

Station	Walk Access	Drive Access	Transfer Access	Total Boarding
Bayamón Centro	5,842	791	16,641	23,724
Complejo Deportivo	639	1.032	2,896	4,567
Jardines de Caparra	1,671	663	206	2,539
Torrimar	1,107	231	375	1,714
Las Lomas	1.689	910	3,051	5,650
San Alfonso	1,156	194	512	1,861
De Diego	1,305	1,039	1,449	3,793
Centro Médico	4,010	172	6,568	10,750
Villa Nevárez	1,986	391	1,494	3,871
Río Piedras	7,737	256	6,255	14,248
Centro Judicial	4,115	28	1,448	5,591
Hato Rey Centro	3,199	57	814	4,070
Nuevo Centro	7,438	465	10,692	18,594
Sagrado Corazón	3,618	112	10,240	13,970
Total	45,512	6,431	62,640	114,492

Table 6-1: Predicted 2010 Daily Boardings and Access Mode, by Station

Station	Walk Access	Drive Access	Transfer Access
Bayamón Centro	25.1%	3.4%	71.5%
Complejo Deportivo	14.0%	22.6%	63.4%
Jardines de Caparra	65.8%	26.1%	8.1%
Torrimar	64.6%	13.5%	21.9%
Las Lomas	29.9%	16.1%	54.0%
San Alfonso	62.1%	10.4%	27.5%
De Diego	34.4%	27.4%	38.2%
Centro Médico	37.3%	1.6%	61.1%
Villa Nevárez	51.3%	10.1%	38.6%
Río Piedras	54.3%	1.8%	43.9%
Centro Judicial	73.6%	0.5%	25.9%
Hato Rey Centro	78.6%	1.4%	20.0%
Nuevo Centro	40.0%	2.5%	57.5%
Sagrado Corazón	25.9%	0.8%	73.3%
Percentage of Total	39.8%	5.5%	54.7%

Table 6-2: Predicted Percentage of 2010 Boardings by Access Mode

Similar numbers are not available for the Transit Center bus and público reorganization, but the system structure that will result from these changes will certainly increase the number of transfers required. Although a number of current bus routes will retain their present configuration, others will be rerouted to serve Transit Centers, requiring many riders to transfer to complete trips that are currently one-seat rides (it is hoped that the increased frequency and improve reliability will compensate for this decrease in convenience). The públicos are also intended to serve as feeders to Tren Urbano and Transit Centers, although they will continue to provide origin-destination service in many markets. Given this, major effort will be required to improve integration between the públicos (which currently operate very independently) and the publicly operated and/or regulated modes.

Since the San Juan public transit system is currently very poorly integrated, it is clear that greater integration between modes will be required for the system to be

successful. A number of different actions are being taken to foster this integration, including the creation of improved physical transfer facilities at the Transit Centers and future Tren Urbano stations. As discussed throughout this research, fare integration is an important element of improved integration, and this is certainly true in San Juan. In addition to creating the need for integration, the construction of the Tren Urbano system and implementation of the Transit Center reorganization plan also create a unique opportunity to implement fare integration, since the system will be in such a state of change. As discussed in Chapter One, fare integration can produce benefits in two major ways: decreased costs due to pricing integration and increased convenience due to technological integration. In San Juan, fare integration has the potential to significantly improve the transferring process in both of these ways. Given this situation, it is apparent that fare integration will help to support the changes being made to the public transit system and create a better transportation system for the future.

The purpose of this chapter is to apply the concepts developed in earlier chapters to San Juan to identify fare integration strategies that might be applicable in this context. The main focus of the analysis will be on the público system, which presents a wide range of obstacles to full fare integration. As privately-operated, individually-owned vehicles, the públicos do not fit well into the traditional fare integration strategies that have been applied to larger, more stable transit agencies. However, públicos are an extremely important element of the San Juan transit system, currently carrying the majority of transit passengers in the region. Although the modeling done for the Tren Urbano Final Environmental Impact Statement assumes that bus ridership will be greater than público ridership in 2010 [51], the públicos will certainly be important to Tren Urbano in the short term, and it is quite likely that they will continue to play an important role well into the future. Although the bus system is clearly important, the públicos are both the most important mode to consider, and the one that presents the greatest barriers to fare integration. It is for these reasons that this analysis focuses principally on identifying and evaluating fare integration strategies that might feasibly be used to integrate the público system with other public transit service.

The first section of this chapter presents a brief discussion of fare integration within the bus system and between the bus system and Tren Urbano. This discussion is kept brief because integration involving publicly owned or regulated bus and rapid transit systems does not represent a unique problem. As evidenced by case studies presented in Chapter Three, this type of integration has been done many times before, and many of the potential strategies have been developed to the point where they are relatively transferable to other systems. Following this overview of fare integration among the "public" modes is a more detailed analysis of fare integration between the públicos and the "public" modes, which presents a much greater challenge.

6.1 Analysis of "Public" Modes

The basic factor that drives the need for fare integration in San Juan is the change in the system structure, which will lead to more transferring, thereby doubling and tripling the cost of many trips if no fare integration were to be implemented. It is clear, therefore, that some fare integration is required, in terms of both pricing and technology. Chapter Two describes in theoretical terms the various fare integration alternatives that are possible, while Chapter Three demonstrates the experience with implementing strategies that already exists. For the public modes in San Juan, most of these strategies are feasible, because the government exercises a high level of control over the system. Given the potentially significant price increases, the general strategy that is most urgently needed is clearly pricing integration. The following sections therefore analyze the two major pricing integration options: transfer discounts and period passes. Although these are two distinct strategies, the important issues are similar enough that these can be discussed together. With regard to the dichotomy in fare integration between technology and policy, the analysis first considers the policy options (while staying away from discussion about specific pricing decisions) and then discusses the relative merits of the different technology options that can be implemented. Throughout this analysis, it is important to take into consideration the interaction between strategies proposed for the public modes alone, and those proposed for integration between the public modes and the públicos. Although these are being considered separately, coordination between them will clearly be needed to avoid creating two incompatible fare integration systems. In

addition, both the constraints imposed by the Tren Urbano fare system and the decision-making timeline presented above must be taken into account.

6.1.1 Policy Issues

The major policy issues directly related to transfer discounts and period passes are pricing and validity. Although the specific decisions in these areas must be made by the local decision-makers in San Juan, it is possible to draw some general conclusions about what strategies would seem to make sense.

Looking first at transfer discounts, pricing requires deciding between free transfers and transfers that are sold at some surcharge over the initial fare paid. Although free transfers are easier to implement and can have stronger impacts, they also lead to greater revenue loss and have more potential for abuse. In the case of San Juan, free transfers seem more appropriate, because the system changes will force a large increase in transfers on the riders. However, any transfer discount will reduce the burden of transferring, and it is up to the authorities in San Juan to decide pricing based on the political and financial situation. With respect to validity, a number of different options exist (as described in Chapters Two and Four); however, in most systems transfers are valid for 1.5 to 2 hours, with restrictions designed to prevent stopovers and round-trips. These types of restrictions also may make sense for San Juan, although other policy issues may impinge on this decision: some provision for stopovers may be desirable to help stimulate development along transit routes and at transfer points.

Period passes are issued for lengths ranging from 1 day all the way to a year. Deciding on a length of validity involves making a trade-off between the increased market potential for shorter lengths and the decreased medium costs for longer lengths. It is also important to take into account the barrier created by the high initial cost, which can make shorter periods more attractive. Because transit riders in San Juan are mainly low-income, the increased initial cost of two-week or monthly passes may create a significant financial obstacle for many riders, making daily or weekly passes more attractive. Most period passes are priced to provide some discount to a regular commuter (assumed to make at least 10 rides per week). This means that a weekly pass is usually priced at

somewhere around 8 or 9 trips, while a daily pass may be priced at, or somewhat above, the cost of a single round trip, with any extra travel being a bonus.

In addition to these basic structure decisions, there are other policy issues that must be dealt with. One of the most important is developing agreement on the pricing and validity issues, taking into account the conflicting goals of the participating agencies. This will certainly be a problem in San Juan, although the process should be eased by the fact that all the "public" modes are under the control of the Department of Transportation and Public Works (DTOP) and the Highway and Transportation Authority (ACT). These two oversight agencies can gather representatives from all participating service providers, and present them with some initial options that can be used to begin discussions on pricing integration. Based on these discussions, it should be possible to develop a workable compromise on fare integration, if the government is committed to such a strategy.

Another important policy issue is the timing of fare integration implementation. As mentioned earlier, there are three major points in the next five years that will provide convenient opportunities for implementation. The most important date is the opening of Tren Urbano, since at that time fare integration will almost certainly become necessary to ensure the success of the system. However, it may make sense to start implementing fare integration earlier, to gain some experience and "debug" the system before adding the complication of Tren Urbano. If there are problems with fare integration at the time Tren Urbano opens, this will create a negative perception of both fare integration and public transit in general.

It is probably too late to introduce fare integration as part of the current set of system changes, but the set of changes planned for 1999 should provide a very good opportunity, because of the likely need for a fare increase (which may double bus fare from 25¢ to 50¢). Introducing fare integration at this point will alleviate the impact of the fare increase on users (who might otherwise wind up paying double and even triple their current fare). From the operator perspective, introducing fare integration concurrently with a fare increase will help counterbalance the revenue loss. Given this apparent win-

win situation, the 1999 changes appears to be the best opportunity for implementing some fare integration, to mitigate the fare increase and prepare for the Tren Urbano opening.

6.1.2 Technology Issues

For both transfer discounts, three major fare medium options are available: simple paper / plastic medium with printed information, paper / plastic medium with information encoded magnetically as well as visually, and stored-value cards with the required information loaded onto the card.

Looking first at simple medium with printed information (such as the transfer issue time or the period of validity of a pass), the major advantage is ease of implementation, since the medium can simply be printed, sold, and accepted without the need for any complicated equipment. However, this type of medium has a number of disadvantages, mainly because the validity information is printed and verified visually. Since the preprinted medium is valid in its basic form, it must be kept secure. For transfer discounts, validation is usually done by making some physical alteration (such as a hole punch or tear), and there are often problems with this validation being done incorrectly (e.g., the wrong time validated); this can lead to problems later when the transfer must be accepted. Some agencies deal with this by preprinting fare medium or using automated transfer printers, but this can increase costs substantially. For both transfer discounts and passes, visual verification can be unreliable and slow, leading to backups at entry points. Printed medium can only be used once, which can lead to significant costs over time, particularly for transfers and shorter-validity passes. Finally, printed medium provides the transit agency with little or no information about usage, which means that a supplementary data collection strategy is needed to obtain information needed for revenue allocation and other management and planning functions.

With magnetically-encoded medium, many of the negative aspects of printed medium are eliminated, but some difficulties remain. Security of the basic medium is less of problem, since it can be validated at the time of issue (although many period passes are printed with information encoded). In addition, the automatic encoding should be accurate and reliable, while the use of automated verification ensures that all transfers

are valid, and can speed boarding (particularly if readers are installed at Tren Urbano station fare gates). Magnetically encoded medium also provide more usage information, which can lead to savings in other area. However, the medium costs are also high, and magnetic issuing and reading equipment must be installed at an additional cost (between $1000 and $3000 per reader, depending on the features).

The final medium option is to carry the required information on board a stored-value card. This can be done using either magnetic stripe cards or smart cards, but is easier with smart cards because of their larger memory and computing power. Use of stored-value cards for this purpose provide all of the advantages of magnetic encoding but without the high medium costs (assuming smart cards are being implemented anyway). The only major problem is that smart cards are most effective for frequent users, meaning that infrequent users (or those who don't use stored-value cards) may not be able to take advantage of these benefits. Given that fare integration is aimed mainly at frequent users (and at turning new and infrequent users into frequent users), this is not as big a problem as it might seem. It clearly makes no sense to implement smart cards purely for the purpose of fare integration, but fare integration provides an additional application that can make smart cards more attractive.

Stored-value cards also constitute a fare integration strategy in themselves, and can act as a unified fare payment medium for a variety of different modes. Based on the current status of the Tren Urbano fare system procurement, it appears that Tren Urbano will open with some sort of stored-value technology, but it is unclear whether this will be a magnetic stripe card or a smart card. From the case studies presented in Chapter Three, smart cards definitely appear superior, indicating that Tren Urbano should ideally use this technology. The cards can then be extended to the bus and público systems to provide a seamless payment technology across all public transit modes in San Juan (although implementing this technology, particularly on públicos, could become a major issue).

6.1.3 Recommendations

6.1.3.1 Conclusions

Based on this analysis, a number of conclusions become apparent. The first is that smart cards are an important element of fare integration, both because of their intrinsic fare integration properties and because of the pricing integration strategies they allow. It seems clear that the Tren Urbano fare decision should be made in favor of smart cards (or at least in a way that preserves the flexibility to implement smart cards at a later date), because of their greater fare integration flexibility. Their high initial cost is mitigated by their long life and by the fact that the costs are decreasing as more such systems are implemented. In addition, some banks in San Juan are studying implementing their own smart card systems, which could then be used on transit as well. The government has also successfully implemented an island-wide medical information card, and if this were changed at some future point to a smart card, this could provide a widely distributed smart card that might also be usable on public transit. Smart cards are also suitable for providing user-side subsidies, where general prices are raised to market levels, with subsidies targeted at users who cannot pay those higher fares (such as elderly, students, and low income riders). This subsidy payment can easily be loaded onto a secure portion of a smart card which can only be used for paying transit fares, making it difficult to abuse the subsidy. Given all these factors, it seems likely that smart cards can be successful on public transit in San Juan, and should certainly be pursued as part of the Tren Urbano fare system.

The second conclusion involves the importance of pricing integration. The system structure changes that are planned will increase the amount of transferring required, which will lead to a doubling or tripling of the cost of many current trips. Combined with the fare increase that may take place in 1999, this will mean that the price of a particular trip could increase by a factor of six in a period of five years. Given the largely low-income public transit riders, this is clearly not acceptable. This makes it evident that fare integration cannot simply involve technological integration, but must also include a strong pricing integration element. Table 6-3 illustrates one potential fare integration strategy, the implementation of daily and weekly passes for the public modes (assuming a

50¢ bus fare and a 75¢ Tren Urbano fare, which appears to be the most likely scenario after 1999).

	Bus Only	Tren Urbano Only	Bus and Tren Urbano
Day Pass	$1.25	$1.50	$2.25
Weekly Pass	$5.00	$7.00	$10.00

Table 6-3: Potential Daily and Weekly Pass Prices

These figures are only intended to be illustrative, but they may provide a good starting point for further fare integration discussions, including both passes and transfer discounts.

The third conclusion is that the changes planned for sometime in 1999 provide the best opportunity for implementing fare integration. By implementing fare integration within the bus system and between the bus system and the públicos (as discussed later in this chapter), it will be possible to mitigate some of the negative impacts of these changes while also preparing for further integration after Tren Urbano opens. Because of the lead time required to procure the technology, it is unlikely that it will be possible to install smart cards on board buses within the next two years. Instead, simpler pricing integration strategies, such as the printed medium passes and transfer discounts discussed above, should be pursued over the next two years, so that something can be in place at the time the next set of system changes take place. (Pricing integration with the públicos should also be pursued, as will be discussed in the next section.) Once this has been accomplished, the next goal should be the implementation of smart cards on buses (and potentially públicos), to make full technological integration possible at the time Tren Urbano opens or shortly thereafter. This will help support the feeder service to Tren Urbano and create the image of an integrated public transit system that is attractive to current users.

If smart cards cannot be implemented on the bus system by the time Tren Urbano opens, some temporary fare integration strategies could be put in place, using simpler technology until smart cards become available system-wide. These interim strategies could build on the passes and/or transfer discounts that have previously been

implemented in the bus system. Although the incompatibility of the media could create problems, it may be possible to develop some hybrid fare medium that can be used in both systems.

Overall, the timeline for implementing fare integration among the public modes in San Juan should be as follows:

Year	Actions
1997	• Planning begins for pricing integration on buses (transfer discounts and period passes), including interagency discussions. • Tren Urbano fare system procurement includes smart cards (or option to upgrade to smart cards in near future). • Procurement of smart card technology for buses (and potentially públicos) begins.
1999	• Pricing integration is implemented on buses (and potentially públicos), using transfer discounts and/or period passes.
2001	• Tren Urbano opens with smart card system in place. • Smart card system is implemented on buses, providing a universal payment medium and allowing pricing integration strategies to be extended to include Tren Urbano.
2001+	• Implementation of smart cards on públicos is pursued. • New pricing integration strategies are implemented on Tren Urbano, buses, and públicos, taking advantage of smart card flexibility.

Table 6-4: Proposed Timeline for Fare Integration in San Juan, 1997-2001+

6.2 Analysis of the Público System

As discussed elsewhere, the público system presents a number of major obstacles to fare integration. By their very nature as a privately-owned, independently-operated informal jitney service, the públicos do not fit well into the typical framework of formal public-sector fare integration programs that have been implemented elsewhere (and described above for the public modes). None of the case studies provides information that is directly applicable to the públicos, because they are so different from the publicly operated modes that are typically involved in fare integration. Each público owner has a very strong incentive to maximize his or her own profit, which leads to behavior that is

very different from the behavior of a typical salaried public-sector vehicle operator. As a result, developing fare integration strategies for the públicos requires a broader approach. This section will start by briefly considering each of the general fare integration strategies proposed in Chapter Two, and then make a preliminary identification of those that may potentially be applicable to the San Juan públicos. Following this preliminary analysis, the strategies that show some potential will be consolidated into a manageable set of alternatives that can be analyzed using a subset of the evaluation criteria proposed in Chapter Four. Based on this analysis, it will be possible to identify strategies that might work for the públicos as well as predicting what obstacles are likely to be encountered in attempting to implement these strategies.

6.2.1 Potential Fare Integration Strategies

The following sections present a preliminary analysis of the three major fare integration strategies that have been identified (transfer discounts, period passes, and stored-value cards), to develop a more focused set of fare integration strategies that can be analyzed in greater detail using the criteria presented in Chapter Four. Before beginning it is important to state two major assumptions about the público system. The first assumption is that the públicos will continue in their current private ownership mode, without major government subsidy. If a subsidy is provided, the level of government control should increase considerably, which will fully or partially eliminate many of the obstacles to fare integration discussed below. The second assumption is that the público operators will want to be paid a full fare for every passenger they carry (i.e., they will not accept any revenue loss as a result of fare integration). From the perspective of customers this need not be a major problem, since customers will only care about the discount on their entire trip (as opposed to the specific discount being given on each mode), but it will mean that to prevent negative impact on customers the government will have to bear the entire cost of whatever discounts are provided. Again, if the drivers are willing to accept any revenue loss, this will change the analysis considerably, but the most conservative and most likely assumption is that they will not.

6.2.1.1 Transfer Discounts

Typically, transfer discounts between different operators involves a revenue allocation agreement whereby all participants absorb a portion of any revenue loss. If transferring between the operators is reasonably balanced, they may not need to worry about reimbursing one another for transfers, while if there is a clear inequality in transfer patterns, some formula must be developed to allocate the collected revenue between operators. Because of the precarious financial situation of the público drivers, it is unlikely that they will be willing to enter into any agreement where they do not receive full revenue for every passenger that they carry. This means that the government will need to absorb the entire revenue loss from fare integration, and reimburse the públicos for any discount that they provide to riders. It is important for the government to realize that fare integration with the públicos will not be cheap but will require significant public sector commitment.

This issue of revenue and revenue loss points to another problem: obtaining the information required to allocate the appropriate revenue to público drivers. In a traditional transfer discount agreement, revenue allocation is typically done using information collected from the fare system, or through periodic surveys of travel and transfer patterns (or a combination of the two). With the públicos, surveys are not a feasible option, because it would be prohibitively expensive to perform enough surveys to produce acceptable information on 3,000 separate, individually-operated vehicles. Because of this, it will be necessary to rely on fare system data to perform this allocation. In the case of simple transfer discounts, the most obvious way to gather the information is by having drivers turn in the physical transfer medium they collect, with the government reimbursing them for the difference between what the passenger paid when boarding with a transfer and what that passenger would have paid without a transfer. However, since passengers will wind up paying less for their transfers than the drivers will be able to receive by turning them in to the government, there will an incentive for público drivers to purchase transfers illegitimately from passengers who are not actually transferring. Even if passengers have to pay for the transfers, the público drivers will still receive a greater sum from the government, which would allow both drivers and passengers to

make a profit on the margin. Without attempts to control this, a simple transfer discount strategy could become extremely costly for the government.

The final difficulty with respect to the públicos is the method whereby the revenue owed to drivers will be physically distributed to drivers. Currently, drivers use their daily income to pay their expenses for that night and the next day. They are not paid on a regular cycle like typical salaried worker, and tax deductions are not automatic. Because of this, they will not be interested in a revenue allocation agreement where they are paid on a biweekly or monthly basis, or where their revenue is not anonymous. Although it might be possible to convince the públicos to accept payment on a weekly basis, they are likely to be reluctant to enter an agreement where they will be required to wait longer than a day for the money they are owed.

None of the problems described above makes the use of transfer discounts impossible, but any plans that are developed must take into account these constraints. Because the government will be absorbing the entire cost of the discounts that are provided, it is necessary to consider transfers from público to bus and rail separately from transfers from bus and rail to público, because of the differences in revenue allocation. Other issues identified will have similar impacts on the fare integration strategies that are possible, and will eliminate many strategies that would work in a more traditional environment.

As discussed in the context of the public modes, the two major issues in transfer discounts are pricing and validity. These decisions must be adjudicated by the decision-makers in San Juan, taking into account the increased revenue loss resulting from discounts and the potential for abuse by público drivers. Printed medium should be sufficient (as long as it is reasonably counterfeit-proof), since magnetic transfers provide little advantage (público drivers have a strong incentive to track all transfers they receive) while their cost and unreliability represent significant potential disadvantages. To keep the revenue allocation problem tractable, it is apparent that transfers issued by públicos should be valid only on bus and Tren Urbano (but not on other públicos), while transfers issued by the public modes should be valid only for a single público ride. Given the likely ridership patterns, these are unlikely to represent significant constraints. Based on

these overall principles, the following two transfer scenarios have been developed for more in-depth analysis.

- **Paper Transfers: Público to Tren Urbano or Bus** - These transfers would give passengers originating on públicos either a one-way or round-trip fare on their subsequent travel (separate transfers would be needed for bus and Tren Urbano, because of the different fares). The government would sell books of transfers to público drivers below their face value, and the público drivers could then sell these to the passengers when they pay to board the público, either at the full fare (i.e., at a profit to the driver, providing a financial incentive for público drivers to serve the Transit Center and Tren Urbano stations), or at a discount (creating a benefit for riders).

- **Paper Transfers (Tren Urbano or bus to público)** - These transfers would be issued to riders boarding Tren Urbano and bus, and would be valid for travel on board a single público. The transfers would have to be issued only on payment (as opposed to having ticket-issuing machines, as is done at many rapid transit stations) to ensure that only one transfer is available for each fare paid. On buses, these transfers could be issued by transfer-issuing machines attached to the farebox, with a transfer issued only when the passengers requests. At Tren Urbano stations, the transfers could either be sold by station attendants, or be issued directly by the turnstiles at the time of payment. Even if the transfers are free, it is crucial that transfers only be available at the specific time a fare is paid, as otherwise it would be much too easy for publico drivers to obtain extra transfers that could be turned in for payment from the government. Passengers with a transfer would then be able to board a público at some discount, with the driver retaining the physical transfer document to receive payment from the government for the difference between the normal fare and the transfer fare actually paid.

6.2.1.2 Period Passes

Implementing period passes on the públicos involves many of the same problems that are encountered with transfer discounts, because it will be necessary to pay the

público drivers full fare for every rider, even if passengers are boarding using a pass. To do this, some accurate record of the number of pass boardings is needed, since it is not feasible for the drivers to produce physical evidence. Although the simplest way to do this would be have drivers keep logs of pass boardings, the incentive and potential for abuse is much too high. Passes could have tear-off vouchers that drivers could turn in for payment, but this would be very complicated, and would also have a high potential for abuse. The other option is to have the passes verified electronically, using a reader on board the vehicle that will keep a log of pass boardings. This information can then be downloaded to determine how much money is owed to each driver. However, a driver could pay pass-holders to swipe their card, even if they are not planning on riding in a público. This would have no cost to the pass-holder (since the pass is prepaid) and would increase the payment to the driver.

Paying the drivers the money that is owed to them will also be a problem, because it will be necessary to analyze the usage information on a daily or weekly basis. The público route associations could play an important role in this context, by acting as intermediaries between the government and the individual drivers to ensure that each driver in a route association receives the money he or she is owed in a way that is anonymous for the drivers. Alternatively, if pass sales can be designed such that drivers receive their money in advance (e.g., by having the drivers sell the passes for a profit), this will eliminate the need for the government to pay drivers or route associations after the fact.

As discussed in the section on integration between the "public" modes, income constraints appear to dictate that period passes not be valid for more than one week, or else the initial cost will represent a major obstacle for many transit users. The following sections describe two pass options that will be considered for further analysis.

- **Day Pass Sold on Públicos** - This pass is similar to the first transfer discount proposed above, because it would be sold by drivers to passengers as they board in the morning. The original passes would be sold to the drivers at a discount by the government (once again possibly using the público route association as middle-men).

The drivers would then sell these passes to users for slightly less than the price of two full Tren Urbano or bus fares, entitling the rider to unlimited travel on that mode for the entire day. The rider could then use the pass all day on bus, Tren Urbano, or both (depending on the pass purchased), which would encourage riders to use public transit to make short trips for shopping and meals. This strategy does not provide a discount on the público (although it could be modified to do so), but it does provide a discount on the total cost of making the trip, which is what matters to the users. In most cases it means that they receive some discount on their basic work journey, and also receive the benefit of unlimited travel. Drivers, for their part, earn a profit equal to the difference between the price at which they can purchase the passes from the government or route associations and the price at which they can sell it to a customer. This provides the drivers with an incentive to provide feeder service, which will help to ensure the success of the revised system structure. In addition, they do not need to worry about the anonymity of their revenue, and they still receive their revenue on a daily basis. It is possible that público drivers will only serve as feeders in the morning, because that is when they can sell the passes. If this becomes a problem, the government could begin to pay drivers for turning in used passes at the end of the day, thereby encouraging them to provide service on the return trip (alternatively, the government could fall back on simple transfers to ensure continuous service).

- **Weekly Pass** - In contrast to the relatively specialized day pass described above, this scenario would involve a simple weekly pass valid on público, bus, and Tren Urbano, similar to weekly passes in place elsewhere. The pricing would be a policy decision that would need to be made by policy-makers in San Juan, but it would need to be higher than the regular pass for bus and Tren Urbano (described earlier), probably in the range of $13-$15 per week. To provide some reasonably reliable usage information, this strategy will require the installation of pass readers on board the vehicles. The information could be downloaded either by transit employees while drivers are waiting at público terminals, Transit Centers, and Tren Urbano stations, or by representatives of the route associations.

6.2.1.3 Stored-Value Cards

The two main options for stored-value cards are magnetic-stripe cards and smart cards. The major obstacle to implementing either type of stored-value card is the need to install the necessary equipment on board the vehicles, maintain that equipment, and then download the information that is stored in memory (mainly for revenue allocation). However, when one compares the two technologies, the advantages of smart cards become apparent, particularly if the public modes implement smart cards as recommended above. In terms of cost of the technology on board the vehicles, smart cards are reasonably competitive with magnetic stripe cards, although the readers are somewhat more expensive. However, this is offset by the fact that maintenance costs for smart card readers are considerably lower over the life of the reader. This is particularly important in the case of the públicos: since they do not return to a central garage at night, the substantially reduced maintenance needs will make implementation much more feasible.

Another advantage of smart card readers (at least for the contactless cards that are more popular with transit agencies) is that they are completely sealed, without the openings needed for magnetic card readers. In addition to reducing maintenance requirements and eliminating problems with foreign objects getting stuck in readers, this also makes them more secure. Smart card readers can also be quite small and inconspicuous, and should be relatively easy to install on vehicles. Finally, smart cards can make it much easier for the information on board the vehicle to be downloaded to the government for revenue allocation purposes. Drivers can be given their own personal smart cards, to which they can download the information contained in the smart card reader. They can then have this read (at a Transit Center, Tren Urbano station, route association office, or possibly even a bank), and receive the money they are owed (likely in a confidential manner). Given these evident advantages, the scenario proposed below will analyze the potential for implementing smart cards rather than magnetic-stripe cards on públicos.

- **Smart Cards on Públicos** - This strategy will involve the installation of smart card readers on board públicos that provide feeder service to Tren Urbano and Transit

Centers. This system would be intended to interact with the one that has been recommended for the public modes, to provide a seamless payment system for all public transit. Although this system could be used to implement either transfer discounts or period passes, this scenario will consider the impact of the technological integration, without explicitly considering the potential for more sophisticated pricing integration. As described above, the readers could then also be used to download the information needed by the government and make payments to the drivers.

6.2.2 Evaluation Criteria

Before analyzing each strategy, the first step is to choose from among the evaluation criteria presented in Chapter Four those that should be used for this specific evaluation. This section briefly analyzes each of the proposed criteria and identifies a focused subset that will be used to consider the público integration techniques described above.

6.2.2.1 Usage Criteria

Both usage criteria are eliminated from this analysis, for two main reasons. First, analyzing new ridership impacts is not crucial to this evaluation, because future ridership estimates have already been made. Rather, the main objective is to develop effective fare integration strategies that will help to support this system structure and help achieve these previous ridership predictions. Second, the demand model developed for the Tren Urbano project does not provide a simple way of representing the strategies being analyzed, so it would be very difficult to produce meaningful ridership results.

6.2.2.2 Financial Criteria

- **Fare Revenue** - The most significant issue in terms of fare medium is the revenue loss that will result from the fare integration strategies proposed, and the problems that will result from this loss. Because the demand model will not produce meaningful results for these strategies, "conservative" estimates that will overstate the potential revenue loss will be used for this analysis.

- **Revenue Allocation** - The major issue in revenue allocation is deciding whether or not any of the revenue loss will be borne by the públicos. As discussed above, this is unlikely, and it is important to consider how that fact will impact the viability of different measures. In addition, it is important to consider how this allocation will physically take place, particularly under the constraints imposed by the nature of the público system.
- **Cost** - Although it is difficult to develop accurate cost estimates for fare integration strategies, this criterion is included because of its overriding importance. In the following evaluation, attempts will be made to develop some general cost figures, but these should be treated as first-order estimates that will require refinement for any deeper analysis.
- **Fare Abuse / Evasion** - As discussed in the description of the different strategies, there is a strong potential for abuse of the different strategies. This criterion provides a good opportunity to discuss the performance of each strategy in this context.

6.2.2.3 System Criteria

- **Operational Environment** - Although the públicos have a number of unique characteristics that make their operating environment interesting, these characteristics (and their effects) will be covered under the other criteria being considered. This criterion is not included in the evaluation process because it appears unlikely to contribute very much to the analysis.
- **Management Information** - The major management information concern for the públicos is in the context of revenue allocation. Since that will be covered in separate section, this criterion can be omitted.
- **Marketing Support** - In the context of the públicos, marketing is not an important criterion, because there are so many other issues that must be addressed first. For this reason, it is excluded from further consideration.

6.2.2.4 External Criteria

- **Equity** - Although equity is an important consideration in the San Juan context, it is not something that is extremely crucial to the specific analysis of the públicos, and it is therefore excluded from further analysis.
- **Convenience / Complexity** - In the context of the changes that are currently taking place in the San Juan, the reactions of three different classes of riders must be taken into consideration: frequent users, casual users, and new users. Considering the impact on all three types of rider will provide some of the information needed to determine the worth of each strategy.
- **Acceptability** - For the purposes of analyzing the públicos, assessment of this criterion will focus on the acceptability of the different strategies to the operators involved, in this case the individual público operators and the publicly operated and/or regulated modes.

6.2.3 Analysis of Público Integration Strategies

This section presents the analysis of the five proposed fare integration strategies in the context of the five evaluation criteria chosen above.

6.2.3.1 Paper Transfers: Publico to Tren Urbano or Bus

- **Fare Revenue** - Introduction of these transfers will have a definite revenue impact, since the government will be selling the Tren Urbano tickets at a discount to the publico drivers. However, if the sale of these tickets leads to increased ridership (or allows ridership to reach the level originally predicted), this revenue impact may be negligible, or may be a reasonable price to pay for a successful public transit system. It is also important to consider this revenue loss in the context of what it would cost to set up a new, government subsidized feeder system, as well as the mitigating impact on the potential fare increase.
- **Revenue Allocation** - Because of the structure of these transfer discounts, the revenue loss will be borne entirely by the government, with no need to allocate

revenue back to the públicos after the fact. This is a very attractive feature of this strategy, given the potential difficulties associated with revenue allocation.

- **Fare Collection Costs** - It is difficult to estimate the cost of implementing these transfers, because it is dependent on how many riders take advantage of these transfers. The individual cost of the transfers is quite low (on the order of 1¢ or 2¢) but this can build up over time, since each transfer can be used only once. However, this cost is likely to be fairly negligible compared to the revenue loss, so it may not constitute an important cost element.

- **Fare Abuse / Evasion** - The design of this strategy does not provide a particular incentive for abuse by the drivers, except in the case where a discount on the Tren Urbano fare is provided, in which case they could sell the fare medium to prospective Tren Urbano passengers who did not actually ride on a público. To prevent this type of activity, a system of strong penalties and strict enforcement should be implemented, particularly in the initial stages, to discourage selling of transfers in the areas around stations and Transit Center. In addition, some system will need to be developed for selling the transfers only to authorized drivers, not just anyone who claims to be a driver. This will most likely require the government to issue some sort of identification to público drivers who are currently operating an active route that serves a terminal location (as opposed to holding a license for a route that is inactive); the route associations may be able to provide some assistance in this area.

- **Convenience / Complexity** - From the perspective of regular users of the system, this strategy is likely to be reasonably convenient, and casual users may also be attracted by this convenience benefit. However, the level of convenience may not be enough to entice new users to start riding, particularly without a financial incentive. Overall, this strategy should provide some benefit to people who would ride anyway but is unlikely to attract a large number of new riders.

- **Acceptability** - This strategy is likely to be reasonably acceptable to the públicos (to the extent that any change from the *status quo* will be acceptable), because serving this market will provide them with additional profit. The government will need to

absorb some revenue loss as a necessary cost of convincing públicos to serve the other modes. Therefore, to ensure an adequate level of service to Tren Urbano and the bus system at a reasonable price, the government will need to find some compromise between its own revenue loss and the profit incentive it provides to the públicos.

- **Conclusion** - Overall, this strategy seems feasible, because there is little opportunity for público drivers to abuse the system and the revenue loss should be reasonably small. Unless a discount is provided (which will open up another set of problems), the impact on customers is likely to be relatively small. However, the incentive provided to the público drivers to serve Tren Urbano and the Transit Centers should make it worth pursuing nonetheless.

6.2.3.2 Paper Transfers: Bus or Tren Urbano to Público

- **Fare Revenue** - This strategy is likely to have a negative revenue impact, because of the discount that will be provided to travelers who transfer from bus or Tren Urbano to público. The extent of revenue loss will depend on the policy decision made about the magnitude of the discount, but a lower discount will mean a smaller impact on ridership. In addition, if the increased ridership (or absence of a ridership loss) is large enough, this revenue loss may be acceptable, particularly given the system structure being implemented.

- **Revenue Allocation** - In this case, revenue allocation becomes important, because the government will need to reimburse the público drivers for the discount they provide. They will need to use the information about the number of transfers collected to decide how much revenue is owed to each público driver. However, even after this information has been gathered, it will be difficult and expensive to distribute the money to each individual driver, particularly if it is done on a daily or weekly basis. Although the cost might not be as prohibitive if it were possible to use electronic funds transfer, this is unlikely to be very feasible since the majority of público drivers do not have bank accounts. Overall, revenue allocation with this strategy is quite difficult, which creates a major barrier to implementation.

- **Fare Collection Costs** - As with the previous strategy, the additional cost will depend on the number of users, with a per unit cost of a few cents. Here also, the cost of the medium is likely to be very small compared to the potential revenue loss, so this may not be a particularly important part of the decision-making process.
- **Fare Abuse / Evasion** - The major opportunity for abuse is for Tren Urbano riders to sell their transfers to drivers, even if they are not planning on riding a público. The rider and the driver can then split the difference between the purchase cost and the payment price for the driver, with both making a profit. The major way to curb this type of activity is through strict enforcement of penalties. Such enforcement may be reasonably straightforward, since this sort of abuse is likely to happen in the vicinity of terminals.
- **Convenience / Complexity** - Frequent users are likely to be happy with this strategy, since it will provide them with some discount on their trip. Casual users are likely to be very happy with it, since it will provide them with a cost benefit even though they don't travel regularly. The strategy should also help to attract new riders by providing a financial incentive. However, both casual and new users may have some problems with the complexity of the fare strategy, since they will need to know how to purchase the transfers; this could be a particular problem if they are issued automatically by turnstiles at rail stations. Although this is not necessarily a fatal flaw, it is important to consider how to make this strategy understandable to users who are not very familiar with the fare system.
- **Acceptability** - Acceptability of this strategy is likely to be a problem: both the público drivers and the government may have serious objections. The drivers will not like the fact that they will get paid after the fact, and that some of their income may be more easily traceable. The government will not like the revenue loss that will result, and the fact that revenue allocation may become problematic and expensive. Overall, the benefits to both groups would have to be quite high for them to make the sacrifices needed to implement this strategy.

- **Conclusion** - Although this strategy does provide a discount to the users, it has a number of other problems, including revenue allocation, abuse by drivers, and acceptability to the públicos, that create substantial obstacles. Given these problems, it seems unlikely that this strategy is worth pursuing very far, unless the government is willing to spend a considerable amount of money on revenue loss and enforcement. This strategy illustrates the problems of trying to provide a discount on the público portion of journeys, indicating that it may be easier to confine the discount to the bus or Tren Urbano portion of trips (since where the discount is provided will make little difference to the individual riders). One way to overcome this problem would be to develop a way to have público drivers sell these transfers, so that they receive the money up-front. This could be done by having drivers sell transfers for the outbound trip at the time the rider is making the inbound trip (and *vice-versa*). When users are boarding a público on the evening trip, they could purchase a discounted transfer for travel on bus or Tren Urbano the next morning. When they board a público for the morning trip, they could then buy another discounted transfer that would be valid on Tren Urbano or bus that evening. When they get to their transfer point, they can board using the transfer purchased the previous evening, while they will use the transfer purchased that morning on their return Tren Urbano or bus trip that evening. In this way, users are given a discount, some of the potential abuse problems are eliminated, and the público drivers are given a profit incentive to serve the public modes throughout the day. Although this modified strategy presents a number of logistical problems for riders, drivers, and the government, it is a concept that may help to eliminate some of the negative characteristics of other fare integration strategies that have been proposed.

6.2.3.3 Day Pass Sold on Público

- **Fare Revenue** - This strategy will create revenue loss for government, both because the passes are sold to the públicos at a discount and because they allow riders unlimited travel on "public" modes. However, the públicos will see increased revenue, which will help their financial situation. Given the government's need to

establish feeder service to the terminals in any event, this may be a relatively cheap way of encouraging público service while also providing an attractive discount to riders.

- **Revenue Allocation** - This strategy should present no major revenue allocation problems, because the públicos will receive their profit when they sell the passes to passengers. As with the first fare integration strategy, a system will be needed to ensure that the passes are sold only to drivers who are operating an active route.
- **Fare Collection Costs** - Again, the overall cost of this strategy will depend on the number of users. The per unit cost is likely to be higher (on the order of 10¢), because the medium will need to be validated upon sale using a method such as scratch-off boxes. In addition, there will be distribution costs, but these can potentially be reduced by using the route associations to distribute the medium to directly to drivers. As with the previous strategies, the revenue loss is a more significant cost than the medium cost, but this should be given some consideration in deciding which strategies to implement.
- **Fare Abuse / Evasion** - Drivers could abuse this strategy by selling passes to people not riding a público (this can be dealt with by introducing a separate Tren Urbano only day pass, or by enforcement and fines). Taking steps to ensure that passes are sold only to drivers operating active routes should help cut down on this problem.
- **Convenience / Complexity** - Although this strategy can provide a convenience and travel cost benefit to all riders, it will appeal most to regular users who make traditional suburb-to-city commute trips. In addition to the pricing, which aimed mainly at regular commuters, the simplicity of the strategy may make it appealing to casual and new users who are not very familiar with the system.
- **Acceptability** - As with the first strategy, the drivers should be happy with this, because they will be making a daily profit on selling the passes (although they will have to make some initial outlay to pay for them), and will not have to wait for any reimbursement. From the government's perspective, the revenue loss may be

problematic, but this may be the price they will have to pay for providing pricing discounts while encouraging feeder service to the line-haul routes.

- **Conclusion** - As discussed above, this strategy provides the dual advantages of providing incentives for públicos to feed the major terminals (although the incentive is only strong in the morning), while at the same time providing a discount to users and encouraging greater use of Tren Urbano and buses for shorter trips such as shopping and meals. However, the revenue loss to the government may be relatively high. Nonetheless, this appears to be a reasonably feasible alternative that will achieve two of the major objectives of fare integration with the públicos, and therefore appears quite promising. If problems are encountered with drivers not providing feeder service in the evening, this could potentially be dealt with by creating a "finder's fee" for recapturing the used passes in the evening, or by using some of the one-way transfers discussed earlier, which allow público drivers to make a profit during both peak periods.

6.2.3.4 Weekly Pass

- **Fare Revenue** - This strategy is likely to have a negative impact on revenue, although this is highly dependent on the pricing. However, the pass must provide some discount to regular riders, or it will not capture any significant market share and have a useful impact. The government will need to take into account the tradeoff between revenue and ridership in pricing the pass.

- **Revenue Allocation** - As discussed earlier, público drivers will want to be fully paid for each rider they carry on the pass. Because of this, magnetic pass readers are needed to collect ridership data, which will then be used to determine how much revenue to give to drivers. Given that the pass is issued on a weekly basis, it would make sense to distribute the revenue weekly as well, but the público drivers may not agree to this (especially since they know that the government will have collected all of the revenue at the beginning of the week). Because of this, the cost of revenue allocation may become high, because of the need to provide reimbursement on a

regular basis (not to mention the fact that it is solely for the purposes of revenue allocation that the expensive and maintenance-intensive readers will be needed).

- **Fare Collection Costs** - The major cost of this strategy will be the installation and maintenance of magnetic stripe readers on board those públicos that serve major terminals. These readers cost on the order of $1500, which will represent a significant investment even if not all públicos are involved. In addition, these readers tend to require significant maintenance, and the information gathered will need to be downloaded on a frequent basis, which will have a non-negligible cost. In comparison, the medium cost (5¢-7¢) is relatively minor, particularly since passes are being issued on a weekly, not daily, basis.

- **Fare Abuse / Evasion** - The main opportunity for abuse by drivers is to have pass-holders not traveling on their vehicle swipe their pass, since it will not cost the pass-holder anything and will provide a full rider's revenue increment to the driver. Although this might be controllable through enforcement and surveillance, the risk-to-reward ratio may not be high enough to keep this from becoming a major problem.

- **Convenience / Complexity** - This strategy is clearly aimed at regular users, although the weekly validity will provide some benefit to riders whose travel patterns change on a week-by-week basis. For these users, there is a definite improvement in convenience as well as a likely financial benefit. This strategy should also help to increase ridership, because of the financial incentive and the fact that the marginal cost of travel is very low once the initial cost is paid. However, casual, infrequent riders will derive little or no benefit from this strategy.

- **Acceptability** - From the públicos' perspective, this strategy should be reasonably acceptable (particularly given the potential for abuse). However, they may have some concern over the need to install and maintain the readers on board their vehicles, as well as the time scale on which they will receive payment. From the government's perspective, this strategy may not be very acceptable, because of the potential for large revenue loss, due mainly to the ease of abuse and to the cost of installing the technology.

- **Conclusion** - This strategy does provide a high level of integration for regular users, but the associated costs may be too high for the government agencies that must provide funding. In addition, the potential for abuse and the high equipment installation and maintenance costs will make it difficult to implement, even though it is a good general fare integration strategy. This illustrates the difficulty in implementing some of the traditional fare integration strategies to the públicos, which necessitates the development of more innovative solutions.

6.2.3.5 Smart Cards

- **Fare Revenue** - The impact of this technology on fare revenue should be minor, since the fare collected will remain the same on all modes. It is possible that revenue will increase slightly, because using smart cards will make the system more attractive to users or because revenue collection will be more effective, but the impact should be small.

- **Revenue Allocation** - The data collected by the smart card readers will provide the information needed to allocate the centrally collected revenue to the individual drivers. The use of smart cards may also make it easier to distribute the revenue, if smart cards given to the drivers can be used to download the information stored in the reader; this can then be used to give the drivers the revenue they are owed (moreover, it should be possible to do this anonymously). Although this will require the implementation of a range of sophisticated technology, the resulting benefits will probably justify it.

- **Fare Abuse / Evasion** - Because of the high level of security built into smart cards and the fact that the full amount is deducted for each ride, the opportunity for abuse is very low. The use sealed contactless smart card readers will also make tampering with the equipment difficult, eliminating another source of abuse. Although there is no foolproof system to prevent this type of activity, this is the best that can be achieved with current fare technology.

- **Fare Collection Costs** - The cost of smart cards is a significant barrier, in terms of both equipment and medium. The readers themselves cost around $2000 (plus

installation), while the cards cost about $2.50. However, those costs are expected to decrease considerably in the coming years, as the technology matures and economies of scale develop. In addition, the reduced maintenance costs of the readers are an important factor (particularly in the público environment), while the cost of the cards can be spread out over a period of years, rather than weeks as with a magnetic-stripe card. (There is also the potential for multiple-use cards, as described in the analysis of the public modes). Given these factors, cost may not represent as great a barrier as it initially seems, although it is certainly an important obstacle that cannot be ignored.

- **Convenience / Complexity** - By allowing a single medium to be used for all fare payment, smart cards provide a high level of convenience. If they are implemented properly, they can also be quite simple to use, without the need for either the rider or the público driver to understand more than the most basic functions. This technology will be aimed mainly at frequent riders, for whom purchasing a smart card will make the most sense. In addition, this technology should be attractive to new riders (as long as it is not too complicated), because of the high-technology "glow" that surrounds smart cards as well as the real benefit in terms of convenience.

- **Acceptability** - Público drivers may have significant problems with this technology, because of the need to install and maintain the reader units. In addition, they may not trust the technology to properly track the revenue owed them, and they may believe that the revenue is too easily traced (even if they are told that it is anonymous). The government may also have problems with this strategy, because of the cost involved in installing the technology. In addition, the back-room technology required to manage this system may be too complicated. However, it may be possible to minimize this problem by piggy-backing it onto a system already in place for the "public" modes.

- **Conclusion** - Overall, implementing this technology on públicos will be difficult, but it should not be as impossible as it might initially seem. The government will need to make a significant investment to develop and install the technology, but the benefits may make this worthwhile, particularly in terms of coordination with the other modes.

This is clearly a much longer term strategy, but if the government begins working on it at this point, it may be possible to begin implementing some tests at the time that Tren Urbano begins to come on line.

6.2.4 Recommendations

6.2.4.1 Conclusions

Based on the analysis performed, a number of conclusions can be drawn about fare integration involving the públicos. The major conclusion is that for a trip involving both público and bus / Tren Urbano, the discount should be provided on the public mode. This will provide the same benefit to the user (who care mainly about the total travel cost) while simplifying the involvement of the públicos. If each rider still pays the full fare when boarding, the público drivers will be much happier than if they are providing the discount (even if it will eventually be reimbursed by the government). Although this strategy can potentially create significant revenue loss for the government (depending on the timing of the implementation), it appears to be the price that must be paid to develop an adequate feeder system for the public modes.

The second conclusion is that smart cards appear to be feasible on públicos if, as expected, their costs decrease over the next few years. There are a number of obstacles (such as cost, maintenance, and driver acceptance), these appear likely to be manageable. The benefits of such a system could be very high (particularly if this technology is implemented on other modes), as it will allow the públicos to function as an integral part of the public transit system. Although the obstacles are significant, it appears that they are worth tackling, in order to produce a superior transportation system in the future.

The final conclusion is that although the públicos represent a significant fare integration challenge, they are also a very important part of the public transit system (even with the planned changes), and they can and must be included in fare integration for such a system to be successful. Although fare integration involving the públicos will be difficult, there are some feasible strategies, and these should be pursued vigorously in

order to help ensure the long-term success of the improved public transportation system in San Juan.

6.2.4.2 Choice of Strategies

Of the five fare integration strategies analyzed, three appear to be feasible in the San Juan system: Paper Transfers (from público to bus / Tren Urbano), Day Passes, and Smart Cards. The first two of these strategies are quite similar, and it makes sense to select only one of them for implementation. Based on the analysis, it appears that the Day Pass is the better strategy of the two, and it is therefore recommended for implementation. Attempting to integrate these strategies into the timeline developed in the analysis of the public modes, it seems to make sense to aim to introduce the day pass in 1999, at the same time that pricing integration is being implemented on the bus system This will extend the benefits of pricing integration to públicos and create a reasonably integrated system in advance of the opening of Tren Urbano. For the smart cards, the goal should be to begin implementation at the same time as the bus system, so that all public transit modes will be smart card ready by the time Tren Urbano opens. At the very least, some testing of smart cards on públicos should begin at this point to demonstrate the viability of the technology. In addition to creating an integrated system, procuring the público readers at the same time as the Tren Urbano and bus readers should reduce the unit cost of implementation. Together, these two actions should help to turn the públicos into a reasonably effective feeder system. From the drivers' perspective, they are being given an incentive to serve the other modes, while the users will perceive a reasonably high quality transit system (particularly in comparison to the current system) in return for the increased fare.

6.3 Summary

Table 6-5 updates Table 6-4 to include the público fare integration strategies and summarize the proposed timeline for fare integration in San Juan.

Year	Actions
1997	• Planning begins for pricing integration on buses (transfer discounts and period passes), including inter-agency discussions. • Planning begins for day passes on públicos, including identifying drivers who are interested in participating. • Tren Urbano fare system procurement includes smart cards (or option to upgrade to smart cards in near future). • Procurement of smart card technology for buses and públicos begins.
1999	• Pricing integration is implemented on buses using transfer discounts and/or period passes. • Day passes are implemented on públicos (ensure coordination with pricing integration on public modes).
2001	• Tren Urbano opens with smart card system in place. • Smart card system is implemented on buses, providing a universal payment medium and allowing pricing integration strategies to be extended to include Tren Urbano. • Smart card tests begin on públicos to demonstrate viability of the concept.
2001+	• Implementation of smart cards on públicos is completed. • New pricing integration strategies are implemented on Tren Urbano, bus, and público, taking advantage of smart card flexibility.

Table 6-5: Summary of Potential Fare Integration Strategies in San Juan, 1997-2001+

7. Conclusions and Recommendations

The previous chapters of this thesis have provided an overview and analysis of fare integration. The first four chapters covered fare integration as a general topic, including a review of the literature on fare systems and fare integration, a description of case studies covering related experience in other areas, and the development of an analytical framework to support fare integration decision-making. The last two chapters considered the specific application of fare integration to the San Juan Metropolitan Area, using the framework developed earlier to analyze a set of fare integration strategies. Based on this research, a number of conclusions and recommendations can be made, both specific to the San Juan area and more generally about fare integration.

7.1 General Methodology

7.1.1 Conclusions

Over the years, a fair amount of study has gone into the topic of fare systems, and the related fare policy and technology issues. However, fare integration as such has not received a great deal of specific attention in this research, even though it is a fairly common fare system action. For this reason, the different elements of fare integration have not been defined in a systematic way, which makes it difficult to follow a specific methodology when considering fare integration actions. In addition, little work has been done in evaluating potential fare integration strategies, and implementing fare integration is often justified as a "good idea," without very much supporting analysis. This research has attempted to define the major issues that must be considered when looking at fare integration, and then propose an analytical framework that can be used to evaluate potential fare integration actions.

Based on this analysis, three general fare integration strategies have been identified:

- **Transfer Discounts**

- **Period Passes**
- **Stored-Value Cards**

For each of these strategies, a number of different decision areas were identified to provide decision-makers with some guide to the available options for fare integration.

The analytical framework that has been developed identifies evaluation criteria in four major areas:

- **Usage Criteria**
- **Financial Criteria**
- **System Criteria**
- **External Criteria**

In addition to identifying the specific criteria in these general categories, the framework also provides some guidance to decision-makers about how to identify the impacts of a given strategy according to each criterion. Based on this general analysis, it should be possible for decision-makers in other locations to use the information provided to analyze fare integration actions for own their systems.

7.1.2 Recommendations

Based on this research, the following recommendations have been developed:

- **Methodology for Quantifying Impacts** - One of the weaknesses of this analysis is that no attempt is made to quantify the impacts that are identified to allow for a more rigorous evaluation, such as would be done for a cost-benefit analysis. A good next step in this research would be to begin to identify a methodology for converting basic fare integration impacts into more easily manipulated numerical impacts
- **Need to Evaluate Fare Integration** - Fare integration is not always necessarily a "good idea," and it is very important to analyze whether a proposed fare integration strategy is worth implementing *before* proceeding. The analytical framework attempts to provide a methodology than can be used to begin this evaluation process.

- **Impact of New Technology** - The new technology that is currently being implemented provides a great deal of flexibility for fare integration. For this reason, agencies looking at implementing fare integration should give careful consideration to this new technology, because it may allow them to implement a variety of innovative fare integration strategies.

7.2 San Juan Metropolitan Area

7.2.1 Conclusions

The San Juan area presents a number of unique obstacles to fare integration, particularly the nature of the privately-operated públicos. Because of this, analyzing fare integration there requires a two-part approach. The first aspect that is examined is the more traditional, publicly operated and/or regulated transit service: the existing bus system, which is currently undergoing major changes, and the Tren Urbano rapid transit system that is currently under construction. For these two systems, many of the fare integration strategies that have been successful elsewhere can be applied with relatively little difficulty, particularly if this is done in the context of the system improvements currently taking place.

The real challenge of fare integration is San Juan lies in the second element of the transportation system, the públicos, which currently carry the majority of public transit passengers in the San Juan area (although current predictions are that this will change in the future). Because the públicos are privately owned by individual operators, many of the fare integration strategies that have been successful for larger, relatively stable transit agencies are not directly applicable. In particular, the fact that the drivers rely on their daily incomes for their daily purchases creates a profit incentive that can lead to financial abuse of fare integration strategies to an extent that will not happen with salaried drivers. Because of this unique structure, it was necessary to go back to the basic concepts of fare integration to develop strategies that made sense in the context of the público system. Although the two parts of the public transit system have been treated separately for the purposes of analyzing fare integration, it is important to consider how the different fare

integration strategies developed for the two parts will interact to create the entire fare integration system.

The strategies developed take into account the unique characteristics of the transportation system in San Juan, including the characteristics of the institutions involved in transportation, the characteristics of the transportation system, the social characteristics of the population in San Juan, and the nature of the technology currently in place. The analysis also considered the goals that have been developed for the Tren Urbano project and its fare system, as well as the other changes taking place in the area. Based on this understanding of San Juan and its transportation system, along with the structure provided by the general analytical framework, a series of fare integration recommendations were developed.

7.2.2 Recommendations

The analysis of fare integration in the San Juan area led to the set of recommendations presented in the following sections, divided up by the years in which the various actions should be taken.

7.2.2.1 1997 Actions

Clearly, it would be difficult to implement any specific fare integration actions within the next year. However, it is important to begin the process of planning for fare integration as soon as possible. For Tren Urbano, the major effort is the procurement of the fare system, which is currently underway. Based on this analysis, this procurement should be based on a smart card system, or at least a system that can easily be upgraded to smart cards in the near future. This is also a good time to begin thinking about procurement of smart card technology for the bus and público systems, since it may be possible to realize significant savings if these procurements can be done together. In terms of pricing integration, it is important to begin developing strategies for both the bus and públicos. For the bus system, discussions about the different options should be initiated so that some agreement can be reached on what types of transfer discounts and

period passes will be introduced in the coming years. Similarly, discussion with the público drivers should begin, with the aim of developing agreement on a day pass system.

7.2.2.2 1999 Actions

1999 is the next year in which major changes are planned for the bus and público system, with a fare increase likely on the buses. This provides a very good opportunity to implement fare integration, to mitigate the impact of this fare increase and begin the process of integrating the buses and públicos in preparation for the arrival of Tren Urbano. For the bus systems, this will be the time to implement pricing integration, most likely using a fairly simple fare medium that can be replaced once the smart card system is installed. For the públicos, this is the time to implement day passes, as the first step to greater fare integration.

7.2.2.3 2001 Actions

The opening of Tren Urbano provides the next opportunity for greater fare integration. Assuming that Tren Urbano has installed a smart card system, this will be the time to introduce smart cards on the buses (this could even be done slightly before the opening of Tren Urbano, to debug the system and provide an opportunity for rider familiarization). In addition to creating this single payment medium for bus and Tren Urbano, this is also a good time at which to begin the implementation of smart cards on público, at least in a test phase. At this point, the pricing integration strategies developed earlier can be converted to smart card use, to encourage the use of smart cards by riders who are transferring.

7.2.2.4 Beyond 2001

After 2001, the next step is to implement smart cards on the majority of públicos that are providing feeder service, to extend the universal payment medium. In addition, new pricing integration strategies should be considered to take advantage of the increased flexibility available with smart cards. By this point, the public transit system should be significantly improved from its current state, and this improved integration should help to ensure the long-term success of the system.

Table 7-1 summarizes the proposed fare integration actions by year:

Year	Actions
1997	• Planning begins for pricing integration on buses (transfer discounts and period passes), including inter-agency discussions. • Planning begins for day passes on públicos, including identifying drivers who are interested in participating. • Tren Urbano fare system procurement includes smart cards (or option to upgrade to smart cards in near future). • Procurement of smart card technology for buses and públicos begins.
1999	• Pricing integration is implemented on buses using transfer discounts and/or period passes. • Day passes are implemented on públicos (ensure coordination with pricing integration on public modes).
2001	• Tren Urbano opens with smart card system in place. • Smart card system is implemented on buses, providing a universal payment medium and allowing pricing integration strategies to be extended to include Tren Urbano. • Smart card tests begin on públicos, to demonstrate viability of the concept.
2001+	• Implementation of smart cards on públicos is completed. • New pricing integration strategies are implemented on Tren Urbano, bus, and público, taking advantage of smart card flexibility.

Table 7-1: Timeline of Potential Fare Integration Strategies in San Juan

The fare integration actions proposed here are not the only strategies that might be successful in San Juan, but they should provide a good starting point for discussing concrete action. Based on this analysis, it is clear that the fare integration is a crucial element of creating a successful public transit system in San Juan. The system changes being proposed will force a significant amount of transferring, and fare integration is an important step in ensuring that this system works as designed. By implementing fare integration, along with a number of other improvements, it should be possible to create a high quality transportation system that will support the continued growth of the San Juan Metropolitan Area.

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Appendix - Case Study Questionnaire

Survey Instructions

- This questionnaire is being distributed to a number of agencies, so not all of the questions (or answer choices) will necessarily be applicable to your agency.
- Most questions ask for your knowledge about your agency specifically, while a few ask for general public transit information about your metropolitan area. Please answer questions about other agencies to the best of your ability and knowledge, but do not go out of your way to obtain extra information.
- If any question would be better answered using existing documentation or material, please don't hesitate to include that instead.
- Throughout this questionnaire, fare integration is defined as follows:

  Actions taken with respect to fare policy, structure, and technology that facilitate movement between two different vehicles. These vehicles can be of the same or of different modes, and may be operated by a single operator or by different operators.

- If you have any questions or concerns, or require clarification of any of the questions, please contact me at the number below.

QUESTIONNAIRE BEGINS ON NEXT PAGE

1) System and Fare Structure

Modes Operated: Please check off all public transit modes which operate in the metropolitan area where your agency is located. Please indicate those that are operated by your agency and those that are operated by other agencies in your metropolitan area:

Operated by Your Agency	Operated by Another Agency	
☐	☐	Fixed-Route Bus
☐	☐	Light Rail Transit
☐	☐	Heavy Rail Transit
☐	☐	Commuter Rail
☐	☐	Paratransit
☐	☐	Other (please indicate): _____

Fare Instruments: Please check all fare instruments currently used by your agency:

Single-Use:

☐ Cash
☐ Tickets
☐ Tokens
☐ Other (please indicate): _____

Multiple Use / Bulk Sales (≥ 2):

Full-Price	Volume Discount	
☐	☐	Ticket
☐	☐	Token
☐	☐	Other _____

Passes:

Type / Duration	Visual Verification (e.g. flash pass)	Automated Verification (e.g. swipe card reader)
Daily	☐	☐
Multiple-Day	☐	☐
Weekly	☐	☐
Monthly	☐	☐

Stored Value Card:

Mode / Type	Bus	Heavy Rail	Light Rail	Commuter Rail	Paratransit	Other (indicate) _____
Magnetic Stripe	☐	☐	☐	☐	☐	☐
Smart Card	☐	☐	☐	☐	☐	☐

Other:

☐ Indicate any other fare instruments in use _____

_____

_____

Fare Differentiation: Please indicate any modes on which your agency uses either distance-based pricing or time-based pricing (peak vs. off-peak):

Distance-Base Pricing	Time-Based Pricing	
☐	☐	Fixed-Route Bus
☐	☐	Light Rail Transit
☐	☐	Heavy Rail Transit
☐	☐	Commuter Rail
☐	☐	Paratransit
☐	☐	Other (please indicate): _____

Fare Pricing: Please enter the cost of each fare instrument for single-mode (without transfer) travel for each mode. For modes which employ distance- or time-based pricing, please indicate the range of prices

Mode / Fare Type	Fixed-Route Bus	Light Rail Transit	Heavy Rail Transit	Commuter Rail	Paratransit	Other _____
Base Fare (i.e. cash)						
Elderly / Disabled Fare						
Student Fare						
Discounted Multiple-Use / Bulk Purchase						
Daily Pass						
Multiple-Day Pass (list duration)						
Weekly Pass						
Monthly Pass						
Other _____						

Please attach any additional or supporting information, such as brochures or passenger handouts, which include information about your agency's fare policy and structure.

2) Intra-Agency Fare Integration Strategies

Please provide information about the different fare integration strategies that are in place at your agency. This information could be in the form of brochures, pamphlets, or informational items that are provided to passengers, or documentation and reports that are related to your agency's fare integration strategies. Types of fare integration strategies might include the following:

Free or Discounted Transfers: Free or discounted transfers that are available among and between modes. Please include information about pricing, length of validity, and media used.

Passes: Different modes on which the same passes are accepted for travel. Please include information about all intermodal passes that are available, as well as their pricing.

Stored-Value Cards: Different modes on which the same stored-value card can be used for fare payment. Please include information about the type of card that is used, as well as how this card is accepted on different modes.

3) Inter-Agency Fare Integration Strategies

Public Transportation Agencies: In the spaces below, please list other public transportation agencies with which your agency participates in any type of fare integration agreement. In the space below each operator, please provide a brief summary of the structure and functioning of each fare integration agreement and/or include any supporting documentation that describes the agreement.

Operator Name: _____

Description of Fare Integration Agreement: _____

_____

Operator Name: _____

Description of Fare Integration Agreement: _____

_____

Operator Name: _____

Description of Fare Integration Agreement: _____

_____

Operator Name: _____

Description of Fare Integration Agreement: _____

_____

Operator Name: _____

Description of Fare Integration Agreement: _____

_____

Operator Name: _____

Description of Fare Integration Agreement: _____

_____

4) Fare Technology

High Technology: Please indicate the current status of the following technologies at your agency. For each technology where there has been activity, please indicate the technology that has been (or will be) replaced (if any):

Status / Technology	Fully Implemented	In Process*	Under Study	No Plans	Previous Technology
Electronic Registering Fareboxes	☐	☐	☐	☐	_____
Transfer Issuing and Reading Machines	☐	☐	☐	☐	_____
Mag-Stripe Pass Readers	☐	☐	☐	☐	_____
Mag-Stripe Stored Value Cards on Rail	☐	☐	☐	☐	_____
Mag-Stripe Stored Value Cards on Bus	☐	☐	☐	☐	_____
Mag-Stripe Stored Value Cards on Paratransit	☐	☐	☐	☐	_____
Smart Cards on Rail	☐	☐	☐	☐	_____
Smart Cards on Bus	☐	☐	☐	☐	_____
Smart Cards on Paratransit	☐	☐	☐	☐	_____
Other _____	☐	☐	☐	☐	_____
Other _____	☐	☐	☐	☐	_____
Other _____	☐	☐	☐	☐	_____

* either partially implemented or currently in the procurement process

5) Fare Policy Goals and Criteria

Farebox Recovery: If your agency has a mandated or suggested farebox recovery ratio, please indicate this below.

Farebox Recovery Ratio: _____%

Level of Government That Sets This Ratio:

☐ Local ☐ Regional ☐ State

Evaluation Criteria: For each of the following potential fare policy evaluation criteria (taken from *TCRP Report 10: Fare Policies, Structures, and Technologies*), please provide a ranking on the following scale (circle the appropriate number):

1 = Not Important	2 = Somewhat Important	3 = Very Important

Not Important	Somewhat Important	Very Important	
			Customer Criteria:
1	2	3	Impact on Ridership
1	2	3	Impact on Equity
1	2	3	Convenience
1	2	3	Range of Options
1	2	3	Complexity
			Financial Criteria:
1	2	3	Impact on Fare Revenue
1	2	3	Impact on Fare Abuse / Evasion
1	2	3	Impact on Fare Collection Costs
1	2	3	Impact on Prepayment
			Management / Political Criteria:
1	2	3	Ease of Implementation
1	2	3	Impact on Fleet / Demand Management
1	2	3	Political Acceptability
			Other Criteria:
1	2	3	_____
1	2	3	_____
1	2	3	_____