



## Managing Increasing Ridership Demand

### DETAILS

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# TRANSIT COOPERATIVE RESEARCH PROGRAM

Sponsored by the Federal Transit Administration

Responsible Senior Program Officer: Gwen Chisholm Smith

## Research Results Digest 96

*International Transit Studies Program*  
Report on the Fall 2009 Mission

### MANAGING INCREASING RIDERSHIP DEMAND

This TCRP digest summarizes the mission performed October 31 to November 14, 2009, under TCRP Project J-03, "International Transit Studies Program." This digest includes transportation information on the organizations and facilities visited. It was prepared by Harrington-Hughes & Associates, Inc., and is based on reports filed by the mission participants.

### INTERNATIONAL TRANSIT STUDIES PROGRAM

The International Transit Studies Program (ITSP) is a part of the Transit Cooperative Research Program (TCRP), authorized by the Intermodal Surface Transportation Efficiency Act of 1991 and reauthorized, in 2005, by the Safe, Accountable, Flexible, Efficient Transportation Equity Act. TCRP is managed by the Transportation Research Board (TRB) of the National Academies, and is funded annually by a grant from the Federal Transit Administration (FTA). ITSP is managed by Harrington-Hughes & Associates, Inc., under a contract to the National Academies.

ITSP assists in the professional development of transit managers, planners, and others charged with public transportation responsibilities. ITSP carries out its mandate by offering transportation professionals practical insight into global public transportation operations. The program affords the opportunity for them to visit and study exemplary transit operations outside the United States.

Two ITSP study missions are conducted each year, usually in the spring and fall, and are composed of up to 14 participants,

including a senior official designated as the group spokesperson. Transit organizations across the nation are contacted directly and asked to nominate candidates for participation in the program. Nominees are screened by committee, and the TCRP Project J-03 Oversight Panel endorses all selections. Members are appointed to the study team based on their depth of knowledge and experience in transit operations, as well as for their demonstrated advancement potential to executive levels of the public transportation industry. Travel expenses for ITSP participants are underwritten by TCRP Project J-03 funding.

Each mission abroad focuses on a theme that encompasses a topic of concern in public transportation. Cities are selected according to their ability to demonstrate leading-edge strategies and approaches to public transportation issues and challenges, as reflected in the study mission's overarching theme.

The members of each study team are fully briefed prior to departure. The intensive, professionally challenging, 2-week mission has three objectives: to afford team members the opportunity to expand their network of domestic and international public transportation peers, to provide a forum

#### CONTENTS

International Transit Studies Program, 1

About This Digest, 2

Introduction, 2

Transit System Overview and Planning, 2

Organizational Structure, 5

Increases in Ridership, 7

Service Delivery, 9

Service Optimization, 14

Customer Experience, 18

Revenue Sources and Funding Mechanisms, 20

Conclusion, 23

Appendix A—Study Mission Team Members, 28

Appendix B—Host Agencies, 28

Appendix C—Abbreviations, 29

TRANSPORTATION RESEARCH BOARD  
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for discussion of global initiatives and lessons learned in public transportation, and to facilitate idea sharing and the possible import of strategies for application to transportation communities in the United States.

For additional information about the International Transit Studies Program, please contact Gwen Chisholm Smith at TCRP (202-334-3246; gsmith@nas.edu) or Kathryn Harrington-Hughes at Harrington-Hughes & Associates, Inc. (443-385-0300; khh@tcrpstudymissions.com).

## ABOUT THIS DIGEST

The following digest is an overview of a study mission that investigated how several transit operators and agencies in cities in South America accommodate sudden and significant growth in the number of riders and increasing demand for service. Team members met with transit operators and agencies in Guayaquil, Ecuador; Santiago, Chile; Buenos Aires, Argentina; and Porto Alegre, Brazil. The digest is based on individual reports provided by the mission team members, and it reflects the observations of the team members, who are responsible for the facts and accuracy of the data presented. The digest does not necessarily reflect the views of TCRP, TRB, the National Academies, American Public Transportation Association (APTA), FTA, or Harrington-Hughes & Associates, Inc.

A list of the study team members is included in Appendix A. A list of the public transport agencies and organizations with whom the team met is included in Appendix B. A list of abbreviations is included in Appendix C.

## INTRODUCTION

The mission theme of “Managing Increasing Ridership Demand” was selected to address recent ridership growth in the United States resulting from rising fuel prices, environmental issues, and economic concerns. Although an increase in ridership was welcome, many transit systems did not have the infrastructure or resources in place to handle the rapid influx of passengers.

The four cities in South America visited on this study mission were selected because they have faced and successfully dealt with similar challenges. They have many similarities, as well as some significant differences. Each offered unique insight into managing increasing transit ridership and provided varying

perspectives on serving the mobility needs of their communities.

## TRANSIT SYSTEM OVERVIEW AND PLANNING

### Guayaquil, Ecuador

Guayaquil, located on the Gulf of Guayaquil on the Pacific Ocean, is the largest city and port in Ecuador. It has a population of 2.5 million. When Mayor Jaime Nebot came into office in 2000, he wanted to improve the city’s economy and environment, and he saw an improved public transportation system as the key to both. Through the United Nations Development Program, Nebot brought transit professionals from Curitiba, Bogota, Buenos Aires, and Quito to work with locals on planning the city’s new system. More than three-quarters of the city’s population is dependent on public transport, and they spend roughly one-third of their monthly income on fares (the average per capita income in 2006 was US\$170).

The new mass transportation system, which opened in 2006, is called Metrovia. It replaced a privately owned, very disorganized bus system. Under the old system, there was a surplus of buses running on the same routes, many of which served the downtown area; the drivers, who were dependent on fares for their wages, competed for passengers, pulling over to pick up anyone who flagged them down. The scramble for passengers led to chaotic traffic conditions, and more than a quarter of the traffic accidents in the city were caused by the buses. The average fleet age was 18 years, and security inside the buses was poor; riders were regularly accosted by thieves.

Metrovia is based on a bus rapid transit (BRT) model that utilizes exclusive bus lanes, bus stops specifically designed for high-floor buses, transfer terminals, bus priority at traffic lights, and prepaid fares to create an optimum experience for riders (Figure 1).

### Santiago, Chile

Santiago, Chile’s capital, is located in the center of the country. There are approximately 6 million residents in the Greater Santiago Metropolitan Area. In the 1970s, Chile’s transit system was publicly operated. In the 1980s, the system transitioned to private operation, but without regulation. In the 1990s, the privately operated system began to be regulated. Currently, a private-public partnership operates the Transantiago system, which is run by several differ-



**Figure 1** Metrovia BRT (Guayaquil).

ent service providers. The system consists of BRT, feeder bus lines, and a metro.

Planning for the system was influenced by politicians who wanted to reduce traffic congestion, improve air quality, and consolidate the many private service providers into several large companies. A one-fare structure approach for transit modes created unforeseen problems when implementing the new system. Political pressure to execute the plan before completion created major transportation problems for the passengers, who were not sufficiently informed of the new routes, schedules, and fares. Transit riders throughout the city had to change the way they traveled through the system—and all changes occurred on a single day. As one representative of Santiago put it, “Changing the way 6 million people travel is a cultural transformation, but we didn’t design it as such; we designed it as a transport project.”

Planning and design for the Transantiago system began in 2005, when new companies took control of the existing bus network. The transition to the new system, which included a new fare structure, new routes, and new infrastructure, was fully implemented on a single day in February 2007. Immediately, many problems became evident, causing the media and others to refer to the opening day as the “Transantiago Tsunami.” One of the biggest problems was the fare payment validation system, which failed, forcing Transantiago to offer free rides for a week. Transantiago also lacked a fleet management system, an organized infrastructure, well-informed operators, and an effective educational campaign for riders. There were also too few reloading centers for



**Figure 2** Transantiago “bip!” card.

the prepaid magnetic smartcards (known as the “bip!” card) that were required of all riders (Figure 2).

Transantiago staff had estimated that more than 6,000 buses would be needed to serve the new routes, but only 4,000 buses were on the street when the new system opened that February. The bus contracts were weak, leaving Transantiago with no means of forcing the bus companies to put more buses on the street.

### Buenos Aires, Argentina

Buenos Aires, the capital of Argentina, has 3 million people. When the surrounding metropolitan area is taken into account, the population totals 13 million—equal to one-third of the country’s population. Daily transit ridership is 26 million, 75% of which are trips to and from work and school.

Argentina has a long history of regulated public transit. Originally, tramways, subways, and buses competed with one another, serving self-determined routes, but with fares determined by the government. In 1928, *colectivos* (small buses not designed for public transportation service) appeared on the streets and became immediately popular. Private operation continued into the 1940s, when the government created the state-owned “Transportes de Buenos Aires” (TBA), which consisted of trolleybuses, metro, buses, *colectivos*, and tramways. The state controlled transit operations until 1961, at which time privatization of the urban system was initiated as a means of improving efficiency.

Since 1994, Metrovias (a private company) has held the concession to operate the city’s subway,

light rail line, and Urquiza railway line; in that time period, ridership has almost doubled. In 2004, the national government began subsidizing the subway service as a means of staving off a fare increase. Today, the national government provides 60% of the funds for the metro's operations and maintenance.

## Porto Alegre, Brazil

With a population of 1.4 million people, Porto Alegre is the capital city of Brazil's southernmost state, Rio Grande do Sul. The metropolitan area of Porto Alegre, which is Brazil's fourth largest metropolitan area, has a population of 4 million.

Empresa Pública de Transporte e Circulação (EPTC), the city's public transportation agency, was created in January 1998 to regulate and monitor all the activities related to transportation in Porto Alegre. The system includes movements by car, rail, bus, taxi, bike, and foot on roadways, public spaces, and railways. EPTC was empowered to be the mobility manager of Porto Alegre.

The challenge of managing and growing a total system with multiple operators and public-private agreements is significant. The bus system includes multiple trunk lines operated by a public bus company linked to hundreds of independent bus operators organized by private companies. Planning the structure of the bus system and managing the operating agreements and daily enforcement activities, as well as managing the other modes of transportation, contribute to the complex nature of EPTC's mandate. Its mission today focuses on constant improvement, using an approach that balances cost, quality, and demand.

EPTC began its efforts by developing a plan focused on urban mobility strategies. A key theme in the strategies was linking transportation planning to urban environmental planning. The challenge was meeting the growing transportation demand in a sustainable way. The agency knew that investing in the roadway infrastructure was not a sustainable strategy; as soon as new roads were built and opened, they were immediately congested, which worsened air quality levels.

Porto Alegre started to implement dedicated bus corridors in the late 1970s. With the exception of the recent corridor implemented along Terceira Avenida Perimetral (a 12-km long avenue connecting the northern and southern parts of the city), all other corridors are radial, with one median bus lane in each

direction, low-level platforms, and no overtaking at bus stops. Several of the city's bus corridors that have been experiencing high passenger volumes (exceeding 18,000 passengers per hour in each direction in 2008) are frequently operating with long lines of buses moving at slow speeds during the peak hours.

From the 1999 master plan for the city emerged a "Master Plan for Collective Transportation." This plan looked to strengthen the city's bus transit network through emphasizing a series of trunk and feeder routes, with plans for implementing BRT on some of the existing transit trunk corridors. BRT was adopted because it was considered the best means of attracting choice riders—that is, those with cars; its travel times are competitive with those of a private automobile. A series of portals or terminals would feed outlying routes into trunk BRT services. BRT was selected over light rail because of its lower infrastructure cost.

Porto Alegre's Portais da Cidade (City Gateways) project is a BRT system that will run on top of renovated existing busway facilities and will be complemented by interchange terminals and segments within tunnels and on viaducts. Its first stage links the north/northeast sector to the south/southeast sector of Porto Alegre, crossing the city center. The gateway concept aggregates new functions in a terminal. In addition to the usual integration of the BRT to connecting bus services and other transportation modes (minibuses, cars, bicycles, and taxis), it will also house service and retail activities. Car and bicycle parking facilities provided within the terminal building will enable the integration of the BRT services with private transportation modes. The retail and service areas located in the terminals will provide amenities for both transportation users and neighborhood residents.

BRT lines will mostly operate along renovated busways using high-capacity articulated buses. Bus doors will provide multiple channels for simultaneous passenger boarding and alighting movements at the platforms. Along the BRT corridor, closed stations will allow fares to be collected and verified before boarding, and platforms will be level with the bus floor, allowing easy access for all. The transfer facilities will provide users with convenience, comfort, and security.

Portais da Cidade is an innovative project in the field of urban bus transportation in Brazil as it is being conceived as a means to attract private investors, in addition to the existing bus operators, through a

public-private partnership (PPP). The PPP model, which is being used because more conventional financing mechanisms are not available, allows the private sector to provide the majority of the infrastructure, with coordinated support from EPTC.

## ORGANIZATIONAL STRUCTURE

### Guayaquil, Ecuador

Metrovia services are regulated, controlled, and supervised by an organization formed expressly for that purpose: the Municipal Foundation of Urban Transportation for the City of Guayaquil. The Foundation has a small staff (16 employees), including a general manager of administration; directors of operations, systems, infrastructure, and public relations; a lawyer; and an accountant. Transportation operations, fare collection and management, control and supervision, security, and cleaning are all outsourced.

Metrovia is governed by an eight-member board of directors, which consists of a chairman appointed by the mayor and one delegate representing each of the following: Civic Board of Guayaquil; traffic authorities of Guayas; chambers of commerce and industry and construction organizations of Guayaquil; universities of Guayaquil; private banking association; urban transportation federation; and city council.

The Foundation's income comes almost entirely from property leases and fees from advertisements placed in the terminals and at bus stops. Passenger revenue is distributed among the two bus consortiums; each consortium receives the fares collected on its routes, less the 9.3% that is paid to Metrovia for fare collection services.

### Santiago, Chile

Transantiago is an authority in Santiago that was established by the Minister of Transportation and Telecommunications and ratified by the president of the republic in 2006. The government invests in the infrastructure and provides oversight and coordination of the various components of the transit system. The day-to-day operation of the system is contracted to private companies.

Transantiago oversees operations through a technical coordinator in charge of bus routes, bus stops, user information, technology, and service quality. This includes oversight of the technical monitoring center, which has work stations for 14 radio controllers.

To avoid conflicts of interest, the technical monitoring center is run independently from the operating companies. Among other things, controllers can graphically compare scheduled service with actual service delivery. When issues are identified, the radio controller diagnoses the problem, determines a solution, and places a call to the operating company's own, similar monitoring center. The operating company will then communicate instructions to its individual bus operators.

Radio controllers may also request that the city change the timing of traffic signals, but they must convince the city that the changes are justified. When a metro line is delayed due to an accident or other failure, radio controllers work with bus companies to add more buses on BRT lines that operate parallel to the closed line. Most issues with bus operators are resolved within 20 min of when the phone call is placed.

Contracts with operators outline the service levels and spans of operation to be provided on each line. If the operators fail to achieve those levels of service, they are fined. A contractor receiving 20 or more of these fines is automatically terminated. It is estimated that at one time as many as 300 contract violations occurred in a single day. Contract modifications and the monitoring facility have made it much easier to enforce the provision outlined in the contract, and contractors can now be terminated on the third fine.

Technical coordinators on the Transantiago staff are responsible for system planning. The contracts coordinators are responsible for negotiating and administering contracts with the operators; and they are tasked with continuously making improvements to bus operator contracts. Resources coordinators handle the administration of internal resources (financial and human resources, as well as technology resources).

The contracts coordinator positions were added within the past year. The original negotiations with the bus operators were carried out by technical people who had a background in public transport but no experience in contract negotiation and management. As a result, they unknowingly negotiated bad contracts. The contract coordinators have since, however, been able to modify the bus operator contracts to add incentives for good service and penalties for substandard service. Transantiago has made it a goal to add more incentives as contracts come up for renewal or amendments are made.

As a result of the problems related to implementation of the new bus network, the government is temporarily subsidizing operation of the system.

## Buenos Aires, Argentina

Prior to 1994, the metro system in Buenos Aires was operated by the local government, and service was poor. To improve service, a bid request was issued in 1992 for the operation of the light rail, subway, and commuter rail services. Metrovias was awarded the contract and has been responsible for operating the Buenos Aires subway (Subte), light rail, and Urquiza railway since January 1994. The contract was issued by the federal government, which also provides the funding, but the local government of Buenos Aires retains ownership of the assets. Metrovias's contract includes responsibility for operating the system, maintaining the assets, and executing a capital investment plan for three new subway lines (currently unfunded). The first 4 years of the contract saw a huge improvement in performance levels.

Eligible employees at the government agency running the Subte were encouraged to take retirement before the concession contract was let to Metrovias. A healthy economic situation in the country in 1993 led many to decide to retire, but this meant that many long-time workers, with an extensive knowledge base, were thus not available for Metrovias to hire. To provide a means for transferring those retirees' knowledge to its staff, Metrovias hired five of the retirees as consultants for a 6-month period so that they could share their skills and knowledge (especially with the employees responsible for maintaining the 100-year-old wooden subway cars still operating on Line A). Today, the size of the office staff at Metrovias is half of what it was when the system was run by the local government. Many of the government employees who were not hired by Metrovias still, however, work for the government agency, building extensions to the subway system.

The number of employees represented by unions was also reduced, as Metrovias introduced the 8-hour workday (up from 6 hours under the government-run system). In more than 15 years of operation, however, the number of employees has doubled, partially because in 2003 labor representatives won government support for a return to the 6-hour workday; work hours were cut by 25%, but pay levels remained the same.

Two represented workers—the driver and the person who watches the doors—are assigned to each train. Metrovias tried to eliminate the door guard in 1996, but the government sided with the union, not wanting to see an increase in unemployment. Even though Metrovias is responsible for managing the company, the government dictates the salaries for the unionized workforce. If unions have an issue, they go on strike, and while on strike, workers continue to receive their full pay. Strikes are becoming more common as a result of these practices.

In 2002, the value of the peso dropped dramatically (from the equivalent of US\$1 to US\$0.25). With 75% of trips attributable to commuting to work and school, the government did not want to raise fares and thus decided to begin subsidizing operations in 2004. Today, 40% of operating costs are funded through the farebox, with the remainder subsidized by the government. Since 1994, ridership has almost doubled; the subsidy is independent of the number of passengers.

Bus service in Buenos Aires is provided by private operators controlled and regulated by the government through a permit/franchise process. The government-regulated system, which was implemented in 2002, has resulted in larger, more professional companies providing the bulk of the service with newer buses, many of which are low-floor buses. Service is still competitive, particularly in corridors with no subway service. Fares are not integrated with the subway or the commuter rail. Buses often compete for passengers in the same corridors as the subway and rail; when the subway service improved, more people chose to travel by subway and rail (i.e., the improvements led to an increase in demand).

By law, all stations must be accessible to people with disabilities. The age of the system infrastructure, however, makes modifications very costly and slow. Only five stations have been modified in the 5 years since the law was passed. There is no dedicated funding for future modifications.

## Porto Alegre, Brazil

In a move to decentralize the city's urban transport system, EPTC was created to regulate and supervise activities related to transportation in Porto Alegre. EPTC staff regulate all above-ground movements relating to roadways, public transportation, and traffic signals. EPTC's mission is to enhance

Porto Alegre's livability by providing and managing urban mobility effectively and efficiently while meeting the needs of the population in support of environmentally sustainable development. As the mobility manager for Porto Alegre, EPTC regulates and monitors all modes of transportation including the road network (and the traffic signal system), buses, taxis, school buses, minibuses (called *lotaco*), and the electronic fare system. Their vision is to become the model for urban mobility with values that include courtesy, accountability, and a desire for continuous improvement.

EPTC determines which bus operator will run on each route and defines the schedules in concert with the private operators. By working closely with the provider, EPTC can determine exactly what changes need to be made and where. This generally results in more efficient service and reduces the probability of a fare increase to cover the cost of providing service.

The Association of Transportation Providers of Porto Alegre (ATP) gathers information from 14 bus operators forming three consortiums that operate 80% of Porto Alegre's bus service. The remaining 20% is operated by a public company. ATP is led by a president and three vice presidents, one from each consortium. Public transport in Brazil is not subsidized in any way. ATP looks for creative ways to operate the services so the entire system can be supported by revenue from fares. Any proposed improvements must be self supporting. ATP's contract with the local government must be renewed every 2 years.

Previously, bus operators ran a network of routes and set the fares for those routes. Operators would compete with each other on the same routes. The three consortiums, created on the basis of geographic areas, were formed to reduce the predatory actions between operators. While one consortium operates in a single geographic area, the public company operates in all three consortium areas and actually has the most productive routes.

Decisions within the consortium are made either by consensus or by using a decision matrix. The 14 operating companies that make up these consortiums provide the buses and drivers, and it is their responsibility to make buses available and in good operating condition. The consortium makes sure each of the 14 operators has a balanced system of routes to allow for comparable amounts of revenue collection and to provide revenue to match their expenses.

These three operating consortiums run approximately 1,600 buses with 10% or so of buses being replaced each year.

## INCREASES IN RIDERSHIP

### Guayaquil, Ecuador

Prior to the Metrovia system, individual operators owned the buses, a system that operated similar to a taxi service. This service was described as the *guerra del centavo*, or the "fight to catch the fare." With 83% of the population using public transportation, the competition to capture as many riders as possible was fierce because the fares collected were the operators' incomes.

To maximize their share of the market, operators stopped whenever they saw a customer waiting for a bus, and riders could get off anywhere they wanted, making the service very convenient. Riders paid US\$0.25 per ride in cash to board and alight at any point along the street. Buses stopped at a moment's notice and operated with the doors open to allow for quick boarding and alighting. Travel time was unpredictable due to variations in stops and passenger requests. Buses weaving in traffic to pick up and drop off riders were cited as the cause of a quarter of the city's traffic accidents. Operators carried cash, and operators and riders were often robbed aboard the buses.

An operator typically worked 12 to 14 hours a day. The average age of a bus was 18 years, with some buses still in service at 30 years. Vehicles were poorly maintained and emitted high levels of pollution. The operators were responsible for maintaining the vehicle, but the revenue collected was not sufficient to cover all costs; maintaining the older buses was particularly onerous. A third of the buses carried fewer than 50 passengers. Some areas of the city were underserved or not served at all.

With the introduction of Metrovia, which was much safer and more secure and which ran on a reliable schedule, riders readily made the switch to the BRT and feeder buses. Initially, the feeder buses were overwhelmed by demand, and there was some confusion about how the system would operate. More than 800 buses previously operated by the private collectives were removed from the streets when Metrovia began operating. Where there had been 300 independent operators, now there were two consortiums. The fare remained at US\$0.25.



When the first BRT line opened, it consisted of a total of 40 articulated buses, each bus carrying approximately 3,000 passengers each day. Today Metrovia carries 300,000 passengers per day on its two lines, and a third line is planned to open in 2011.

## Santiago, Chile

During the 1990s and into the early 2000s, dissatisfaction with the system of regulated private buses increased, auto usage increased, and government officials decided that a new approach to providing bus service in Santiago was needed. Politicians wanted to be responsive to this dissatisfaction, as well as find a way to reduce traffic congestion. The congestion was increasingly causing buses to be delayed. In addition, the prosperous economy resulted in higher levels of automobile ownership, and all those new cars on the streets of the city interfered with the efficient flow of buses. A new system was envisioned that would provide high levels of bus service on major corridors and more efficient boarding through the use of dedicated bus lanes and prepaid fares. The new service would be called “Transantiago” and would have as its goals improving the city’s bus services, reducing congestion and pollution, and relieving ridership pressures on the overtaxed Metro de Santiago system.

The planning and design of Transantiago started in October 2005, and the new system was launched on a single day—February 10, 2007. Previously, service was provided by thousands of independent bus operators providing independent, redundant, and inefficient service. The smartcard was used by rail customers only; it was not integrated with the bus system.

On its opening day, Transantiago introduced both a new bus route network and a new fare system with insufficient equipment, minimal public information, and not enough operators trained in the new system. This created an extremely chaotic environment. The bus stops were flooded with people trying to board the buses, but who weren’t even sure which bus they needed to take.

Transantiago was nationally and internationally criticized for its lack of planning and the poorly coordinated implementation of the new system. Although the staff was concerned about the readiness of the system before the start date, outside factors made it impossible to delay the launch. As a result, some aspects of the system were not functional on the first

day, leading to a moratorium on bus fares until the problems could be addressed.

Given that Metro de Santiago was a separate transportation entity with minimal involvement in the bus network change, they did not fully anticipate how the Transantiago changes would affect the rail system. Two years prior, in 2005, the “bip!” smart-card had been introduced to rail customers, and cash was no longer accepted as a form of payment on the Metro. Large numbers of bus riders, frustrated by the confusing new bus routes and being forced to use the bip! card on the buses, decided to use Metro instead; its fixed-rail routing system and well-marked transfer points made it an attractive option. Overnight, ridership on the Metro doubled, from 1.4 million to 2.5 million daily weekday rides.

## Buenos Aires, Argentina

When Metrovias assumed control of the Buenos Aires subway in 1994, it inherited a system that had severe capital infrastructure needs and a poor public image—riders did not consider the system as either efficient or reliable. Since then, ridership has almost doubled, but the network is insufficient for the current demand.

In 2001, an electronic farecard was introduced, giving Metrovias for the first time a means of tracking passenger demand and adjusting supply to meet that demand. When there are more than six passengers per square meter in the system, the supply is increased, if possible. Today, more than one million passengers are carried each day on the subway. To accommodate the higher loads, trains have been increased to six cars (up from four); because of the short platform lengths, trains cannot be longer than six cars.

## Porto Alegre, Brazil

Although Porto Alegre was not initially a planned city, as the city grew its planning focused on accommodating growth through transportation improvements that would connect and integrate new development with existing neighborhoods without destroying their ambience.

Public transit currently has a 39.5% mode share in Porto Alegre. Ridership has declined in recent years as fare increases have exceeded the inflation rate. Although its rate of car and motorcycle ownership is low compared with the United States, the

number of privately owned vehicles in Porto Alegre is growing. The government of Brazil provides significant financial incentives to purchase automobiles and motorcycles, as they are domestically produced and are thus key drivers of the country's economy. The recent economic downturn has spurred the government to enhance such incentives for buyers. Some Brazilians see the incentives to purchase private autos and motorbikes as a much more financially attractive option than relying on public transit. With the incentives, purchasing and operating a motorbike in Brazil is, in some cases, more affordable than the cost of a monthly pass for transit.

This cycle of dwindling ridership coupled with the need to balance the budget each year with fare increases is causing fares to increase faster than inflation, which could at some point make the current formula unworkable. EPTC hopes that system improvements, such as the use of smartcard technology, will improve the revenue flow at a lower cost.

## SERVICE DELIVERY

### Guayaquil, Ecuador

The Metrovia BRT and integrated bus feeder system are based on several operating features designed to offer a high-capacity, rapid urban transit service. These features include the use of high-capacity articulated buses operating at frequent headways on trunk corridors, high-platform station boarding and off-vehicle fare collection to minimize vehicle time at stops, and the use of dedicated transit lanes and signal prioritization at key intersections to give buses an advantage in heavy traffic.

Guayaquil has two BRT corridors in operation; another corridor is expected to open in 2011, and four additional corridors are in the early planning stages. When the first BRT line started service in 2006, approximately 250 privately owned buses were replaced with 40 new, modern, safer buses. The first line, which measures approximately 15 km has 34 stations, two terminals, and a daily ridership of 140,000. When the second line began service in 2008, it replaced 650 privately owned buses; today it carries 650,000 riders each day on a 14-km route.

Buses depart terminal stations on schedule, and passengers are given notice that the doors will be closing. Because of the short headways, typically 5 to 7 min on weekdays, riders at terminal stations sometimes opt to wait for the next bus, so they can be assured of having a seat. The system functions very

much like a light rail operation, but with rubber-tired vehicles operating on pavement. In some cases, the BRT operates on street segments where lanes have been closed to traffic. Stations are generally of a common design, although some stations in the downtown area were sponsored by the private sector and feature a different design (Figure 3).

The system features an integrated feeder network of buses that connect the BRT network with lower density population centers located beyond the terminal stations. The feeder bus routes use standard-size buses, which are better suited than articulated buses for circulating through residential areas. In some cases, the feeder buses bring passengers to one of the terminal stations where passengers transfer to the BRT service serving the central business district. In other cases, the feeder buses circulate in residential areas and then operate adjacent to portions of the BRT system's dedicated lanes to bring passengers closer to their final destinations. Fares are integrated between the feeder buses and the BRT, and transfers are seamless.

The BRT network introduced new fare policies and fare collection procedures. Prepayment and fare integration were concepts new to Guayaquil. Previously, passengers transferring between privately owned buses had to pay a new fare each time they boarded a different bus. Because fares were collected onboard the buses, drivers had to carry cash and make change; not only was this an added task and worry for the drivers, who had to ensure each rider paid the proper fare, but it also made the driver an attractive target to thieves.



**Figure 3** Metrovia downtown BRT station sponsored by private sector.

Metrovia adopted a new integrated fare policy in which most fares are collected at station kiosks rather than on the bus itself. The only exception involves the feeder buses, onto which riders board at a bus stop, rather than at a terminal or station. Within the Metrovia system, all transfers between buses are free at major terminals and station stops, as long as the passenger remains within the prepaid area. Passengers transferring from one BRT corridor to the other can do so within the prepaid area at common stations, and passengers transferring between Metrovia feeder buses and trunk BRT service can do so within terminal stations.

Fare payment can be made by cash at station kiosks and onboard the feeder buses or by electronic fare payment. The introduction of electronic fare payment has improved revenue collection procedures and accounting. The electronic fare payment card is contactless and can be recharged for ongoing use.

Metrovia uses an extensive system of closed-circuit cameras to monitor its vehicle operations and to observe passenger activity at the stations. The control center is located at its Rio Daule terminal. The cameras allow staff to quickly respond to operational interruptions, such as accidents, disabled buses, or nontransit vehicles blocking the bus lanes. The camera system has improved passenger safety and security, resulting in a more positive perception among the public that the Metrovia system is safe and reliable.

## Santiago, Chile

Santiago's extensive subway system—Metro de Santiago—has three lines, 92 stations, and 85 kilometers of track. Each year, 641 million passengers are carried on the Metro.

Transantiago was created to coordinate and streamline the existing privately operated bus service, reduce congestion and pollution, and relieve ridership pressures from the Metro system. The strategy behind the Transantiago service plan was to provide a trunk and feeder system that would improve access in the city and supplement the Metro system. The service plan divided the city into nine zones outside of the central core. Each of the nine zones would have its own unique color-coded feeder network, and passengers would transfer onto BRT service or the Metro to reach the city core. Terminal facilities would enhance the transfer experience between the feeder bus and the trunk line. The bus services would be further enhanced by the use of frequent high-



**Figure 4** Transantiago BRT bus sharing dedicated lane with taxis and motorcycles.

capacity articulated buses on exclusive bus lanes along major arterials. These lanes are open to taxis and motorcycles, but not private vehicles (Figure 4).

Transantiago began service in 2007 with high expectations. The new system was expected to significantly reduce the number of buses operating on Santiago's streets, and nearly 8,000 standard-size or smaller privately operated buses were replaced by 4,500 new articulated and standard-size buses, creating a modern, unified image.

One of the new features of the system was the method of fare payment, which required all passengers to use an electronic stored-value card known as the "bip!" card. Cash fares would no longer be collected on buses. The bip! card provides an integrated fare system between buses and allows for one free bus-to-bus transfer, which was not allowable under the previous bus system. Passengers are also able to make bus-to-Metro transfers for a single, integrated fare.

### *Bus Capacity and Travel Demand*

One of the greatest problems was a miscalculation in the number of buses that the new system would require at start-up. On the first day of service, only about 4,000 buses were in service, not the 5,600 buses that had been planned. The number of buses planned was based on aggressive estimates of travel time savings from the use of new bus-only lanes. Unfortunately, not all of the new bus lanes were available for the system's launch, and traffic signals had not been modified to expedite bus movements.

Only 10 mi of the planned exclusive bus lanes or bus-only streets were available at the start, which represented less than 25% of what was anticipated. The result was that buses took longer to make each trip and could not turn around quickly enough at terminals to provide sufficient capacity.

Because congestion was worse during peak periods, the bus shortage was worse during the peak period than during the off-peak period. In anticipation of the new and improved bus system, many more people than expected turned out to use the system. There were not enough buses to meet the increased demand, particularly for passengers attempting to travel during peak periods for work trips. Dissatisfaction with the new system was immediate.

#### *Fare Payment Procedures and Route Information*

There was little or no public information about how to use the new bus routes. In instances where a direct bus trip under the old system was replaced by feeder line service to a trunk line, passengers did not know where they needed to make a transfer, which bus to transfer to, or how to pay their fare. Passengers who did not have an electronic farecard came prepared to pay their fare in cash but found themselves barred from boarding because none of the buses had fareboxes. Fares remained the same as what the private operators had charged, leading the public to conclude that the new system provided even less value for the money than the old system.

Fare payment procedures were inconsistent. Passengers with bip! cards found that when they transferred between trunk and feeder buses, they were charged a second fare because of an inadequate time window for making free transfers. Other passengers found that they could make a round trip without being charged a new fare. Others simply waved their bip! card at the farebox without actually making contact, and then proceeded to board without having any fare deducted from their card. Sometimes this fare evasion was inadvertent; in other cases, it was deliberate.

Bus drivers were also not properly educated about the new routes, and their lack of knowledge about the new system fueled the public's dissatisfaction. Coordination and oversight among the various bus services were not provided. Passengers who used the trunk lines to travel from the center of the city to outlying areas often found no feeder buses waiting when they got to a transfer point. No staff

had been deployed by Transantiago to manage the street operations.

#### *Management of Contract Operations*

Initially, Transantiago had contracts with 14 different operators. Some of these operators were family-run businesses that had provided bus service during the regulated period of the 1990s. Unfortunately, poor management practices at some of the companies carried over into their early operations under Transantiago, resulting in missed trips and vehicle breakdowns. Other, larger national or multinational contractors evidenced fewer performance problems.

Transantiago had initially negotiated compensation for the contractors based on a lower level of demand. When demand exceeded projections and it became necessary to add service, the contractors did not have a means of recouping their costs. This phase of the project led to contractor dissatisfaction and did not help the already tenuous operation of the service on a day-to-day basis.

The service delivery challenges created with the rushed implementation of Transantiago ultimately led to service improvements in both the Metro and the bus systems. Those changes are detailed in the service optimization section of this report.

## **Buenos Aires, Argentina**

The Buenos Aires transportation system consists of 15,000 buses, 800 km of railway lines, 46 km of subway network, and 7 km of light rail line. Metrovias coordinates transportation on the rail and subway lines. Bus services are provided by private operating companies holding permits/franchises from the government. There is no local public transit authority in Buenos Aires. Public buses operate almost totally without regard to the subway and rail network and with little or no service coordination between the modes.

Present day operations of the Metrovias system appear to be focused on maintaining subsidy levels. Operation of the system is limited by the inability to raise fares despite increasing costs. Fares remained at the same level between 2004 and 2008, despite increases in labor and other operating costs. During this period, the federal government made a policy decision to subsidize operations to compensate for cost increases, rather than raise fares. Yet during the

same period, labor contracts (with the federal government, not Metrovias) were renegotiated to give workers a guaranteed 6-hour workday, while receiving 8 hours of pay.

Other labor-related issues have slowed progress. The union blocked efforts to install ticket vending machines (TVMs) in stations, citing a fear that jobs would be lost. Labor rules also require that trains have two operators, even though only one is needed. Such barriers to innovation have been problematic and serve to increase costs. Fares have also been kept artificially low (when Metrovias wanted to charge higher fares during the peak period, the government insisted that the fares be lower in the peak period); as a result, the subsidy needed to support operations must keep increasing year after year.

Government subsidies cover 60% of operating costs, while fare revenue only cover 40%. A small fare increase in 2008 did not change that ratio.

The demand for expansion is being met with system improvements and developments, including renewal of tracks, station adaptations, and improvements and installation of other amenities on the Urquiza railway line. Renewal and remodeling of subway stations and cars has also contributed to the improvements of the transit system.

Capacity improvements on some of the subway lines have been addressed through retrofitting second-hand commuter rail cars. A complete fleet of very well maintained, 25-year-old cars was purchased from Japan, and those cars began running on Line B in 1995.

The Metrovias system includes electronic fare collection technology, which is estimated to be utilized by approximately 60% of the passengers.

### *Electronic Monitoring*

Metrovias utilizes electronic monitoring of the system. A control center allows staff to immediately determine if operations are proceeding as scheduled and to provide rapid response to emergencies. This monitoring system includes 416 closed-circuit security cameras and 230 closed-circuit television (CCTV) cameras providing station surveillance.

With the subway operations now in private hands, the government has largely turned system planning over to the concessionaire. The government reviews the various options proposed by the concessionaire and chooses which to support. Extensions to the rail system mainly advance as a result of political support,

rather than a long-range, integrated transportation plan that links operations and investments. Funding constraints further limit system expansion.

### *Bus Services in Buenos Aires*

Bus service in Buenos Aires initially developed as competition for the subway and tramway lines in the 1930s and took the form of private collectives. These services went through a time of government control (1940s) and were then again privatized in the early 1960s. When subway and commuter rail lines were privatized in the 1990s, with an added emphasis on providing efficient service, bus ridership fell, mostly due to deteriorating vehicles and facilities. As revenue declined, private operators increasingly directly competed with one another for passengers.

By 2002, the federal government again intervened, announcing that permits or franchises would be issued to private operators to protect their routes from competition. As a condition of receiving a permit, the operator had to agree that all vehicles would be less than 10 years old, have rear engines, and be outfitted with pollution controls. Passenger safety equipment, such as door controls, was also mandated, as were minimum headways of 30 min during periods of lower demand. Because the remaining companies from the private collective era were undercapitalized, they were gradually replaced by operating companies that had the resources to bring in new vehicles with amenities such as low-floor boarding. Some of the private collective companies failed to obtain permits because they could not meet the requirements. A bidding process took place among other firms to determine a new operator, and the successful bidder was often a formal operating company.

Bus services have evolved in Buenos Aires from private, small-scale collective operators that competed with the subway to a more formalized structure where professional operating companies provide the bulk of service. Prior to 1987, there were more than 120 private bus operators, and only one company had more than 350 vehicles. Today, there are 66 operators, and 5 of those companies provide a total of more than 350 vehicles. Companies with less than 100 vehicles represented 56% of bus operations in 1987; today, they represent only 21% of bus operations.

The formalized structure and the government-mandated minimum vehicle requirements have resulted in newer buses with better equipment and

ease of access. Operators still compete with one another, particularly on major corridors where there is no subway service.

### Porto Alegre, Brazil

Transit service in Porto Alegre consists of a coordinated bus transit service and a single suburban commuter rail line. EPTC is responsible for a fleet of 1,572 buses, 403 minibuses, 623 school buses, and 3,922 taxicabs. The bus infrastructure in Porto Alegre consists of 55 km of dedicated busways, 92 stations, and more than 5,000 bus stops with 330 routes. The system's ridership averages 953,000 on weekdays and more than 73 million passengers per year (2008 figures). Completing the transit network is an electrified surface rail line that is referred to as the Metro. The rail line carries approximately 160,000 passengers per day, which represents about 14% of the city's total transit ridership.

Transit service is coordinated by EPTC and ATP. EPTC provides the infrastructure, including bus lanes, stations, and a traffic monitoring program involving an extensive network of cameras. ATP, a consortium of the transportation providers (Carris and three private concessionaires—STS, Unibus, and Co. Norte), provides integrated bus service in Porto Alegre. Carris is a public corporation that traces its roots back more than 100 years to privately operated tramways in the city, which were discontinued in 1970. The three concessionaires represent 14 private operators. Carris provides radial service that links the center of the city with various subregions, while the private operators provide most local service within the subregions. Each of the three private concessions manages bus operations within its sector and may reassign vehicles and drivers from its constituent private operators to each route to ensure that adequate capacity is being offered. Each private operator within a consortium is responsible for providing buses and drivers and for ensuring that the vehicles are maintained in good operating condition.

ATP represents the corporate interests of its member companies, coordinates financial information, and calculates the ratio of expenses to fares in determining fare increases. ATP also determines the distribution of routes between Carris and the private concessionaires, sometimes transferring routes between operating companies to balance costs and revenue. ATP also manages the electronic fare col-

lection system and is responsible for disbursing revenue to Carris and the private concessionaires.

Agreements are in place between Carris and the three concessionaires to reduce overlap and competition for passengers and to ensure that “social” or lifeline routes, which are necessary but often underperform, are cross-subsidized by the more profitable routes.

BRT service has been implemented in phases, with various segments of the BRT network offering different types of stations and vehicles. Some corridors feature high-platform stations with left-door boarding, while others offer standard low-floor buses boarding at conventional-level platforms. Many BRT stations are rather modest stops along the busways, while others are grade-separated stations with stairs to an upper level where transfers are made to connecting bus routes (Figure 5). Some articulated buses are in use, but the majority are standard-size vehicles.

### *Technological Enhancements*

Porto Alegre utilizes technology as a means of improving the efficiency of its transit network. A variety of technological enhancements have been implemented, ranging from electronic fare collection to an integrated traffic camera and automatic vehicle location (AVL) system designed to provide rapid response to problems and to offer customers up-to-date information. The camera system managed by EPTC allows better management of bus operations and allows security or police to be rapidly dispatched if, for example, a private automobile



**Figure 5** Porto Alegre grade-separated BRT station.

enters the dedicated busways. Integration with AVL allows tracking of buses and information on arrivals to be displayed at key boarding locations. All of these functions are coordinated through EPTC's control center.

The electronic fare collection system in Porto Alegre has been well received. At present, more than 85% of fare transactions are processed electronically. However, there are some elements of the fare collection system that function under an older set of operating practices, and these older practices seem to be in conflict with the newer system. Despite the high percentage of electronic fare transactions, buses are still staffed with both a driver and a conductor. The conductor, in addition to his/her role in safety and security, collects cash fares and makes change onboard the bus—services that are needed for only a small percentage of riders. To recharge their farecards, students have to take their money to a bank and get a voucher for the value of the money; the voucher must then be taken to the sales office in the center of the city where value is added to their farecard.

## SERVICE OPTIMIZATION

### Guayaquil, Ecuador

The network of seven planned BRT lines is intended to dramatically reduce the number of buses on the street and to provide faster service in a safer environment. The system relies upon smartcard technology, with rechargeable, contactless farecards used by all riders. The feeder routes have smartcard readers installed at the front door of each bus, but cash is also accepted.

Most BRT stations provide level platform boarding and a closed boarding environment: passengers pay (with their smartcard) when they enter the station. In the downtown area, selected stations are served by multiple routes, and passengers can easily move from one line to another without exiting the station or paying another fare.

Traffic signal prioritization is employed to ensure efficient flow in the BRT right of way. It is estimated that the end-to-end travel time along each route has been shortened by an average of 30 min each way.

The feeder buses are designed such that passengers can access the system by boarding and touching their farecard to the smartcard readers on board. Once the feeder bus reaches a BRT station, it utilizes

doors on both sides of the vehicle to allow for proper “docking” with the BRT station; passengers can exit the feeder bus directly into the BRT station without having to leave the system and re-enter through a turnstile.

With the opening of the third line in 2011, there will be more than 90 km of dedicated BRT lanes. Some portions of the right-of-way have been designed to have two lanes in each direction, which will allow express (skip-stop) operations when needed. Currently, there are 2.2 km of multiple-lane BRT in operation.

Construction has revitalized certain areas, as evident by the crowds milling about the cafés and retail stores. Passenger safety has dramatically improved; not only has there been a steep decline in traffic accidents, but there is almost no crime within the controlled environment (inside the stations and onboard the BRT vehicles). The opening of the first line created 700 new jobs (which included replacing some operator jobs from under the old scheme) with much higher pay and benefits and better job security. In some cases, meals are offered to employees at contractor-controlled cafeterias on the operations and maintenance facility grounds.

The stated goals in moving toward a BRT-anchored system were many, with increased system capacity and fewer transit vehicles on the road being the most significant. Although the system is not yet fully built, the initial lines have led to dramatic reductions in traffic accidents and congestion, increased ridership, improved passenger safety, and revitalized neighborhoods. With the opening of the third line in 2011, the three BRT lines will carry an estimated 600,000 passengers daily.

### Santiago, Chile

Although the initial implementation of the Transantiago system was not smooth, once the bugs were worked out the system served to provide more service with fewer buses and less travel time. Service optimization improvements were made in both the Transantiago and Metro systems.

The smartcard technology that was a key part of the new Transantiago system reduces bus dwelling time by removing the sales transaction from the bus. It also allows for a much more sophisticated fare structure, in which fares can be more easily adjusted to accommodate different times of day, different days, holidays, and so on.

The more than 110 km of segregated busways, bus-only streets, and bus lanes that were introduced by Transantiago have resulted in faster service, which in turn has increased capacity and reduced operating costs.

The 148 prepaid-fare stations, at which passengers tap their farecards as they enter the station, rather than as they enter the bus, allow passengers to board through all doors on the bus. This significantly reduces the loading time at the station and allows more vehicles to serve the same stations in far less time.

New bus stops have been added, bringing the systemwide total to more than 10,000.

By contracting with a limited number of private companies to provide bus service, Transantiago was able to ensure that the vehicles would be newer and safer than the vehicles that had been in service under the prior system, that purchasing would be more efficient, and that driver training and skills would be improved. Fewer private operators have led to enhanced service quality.

By coordinating service with Metro de Santiago, Transantiago has encouraged riders to use both bus and Metro to complete their journeys, and the integrated farecards allow seamless passage through the system.

Transantiago monitors service 24 hours a day, 7 days a week, through its technical monitoring center. The monitoring involves GPS feedback and a series of cameras throughout the city, with each radio controller responsible for one business unit/bus operating company (some having up to 1,000 buses.) The content on the large screen in the monitoring center is controlled by engineers and the radio room chief. The information displayed is related to the current operating condition. A night shift was added in the monitoring center in late October 2009 in response to complaints that buses, which were supposed to operate every 30 min, were operating every 90 min at 3:00 a.m.

When the launch problems with Transantiago caused many riders to switch to the subway, Metro de Santiago had to quickly devise and implement solutions for the need of added capacity in the face of an almost overnight doubling of demand. Metro, while limited in its own capital capacities and relying upon a measured and systematic plan for growth adopted earlier, quickly applied several techniques to increase train speed and thus increase capacity.

Skip-stop (express service) was introduced on the busiest lines (Figure 6). While common in bus



**Figure 6** Santiago Metro skip-stop train and crowd control personnel.

transit and in some rail systems elsewhere, the Metro system in Santiago was not designed to operate in such a way. By skipping some stops, a train can move end to end through a line much faster and thus add capacity to the system. The key is that passengers must know which trains to board to reach their destination. As journey time became faster under skip-stop operations, riders became more pleased with the system.

Short-turns were implemented where infrastructure allowed. Metro system was designed so that some trips on some lines could be ended short of the last station, where capacity demand is the lowest; this would allow the train to re-enter service in the opposite direction more quickly. The result is higher frequencies at stations near the geographical center points of the route, and lower frequencies at the ends. This technique increased capacity where it was needed most, without requiring additional trains or service hours.

Fares were increased during peak hours as a means of encouraging riders to travel in nonpeak hours. Smartcard technology meant that only a simple reprogramming of the software was required to make this change.

All train maintenance activities were shifted to the overnight hours. To reduce the number of out-of-service rolling stock (cars that were not available for service due to maintenance requirements), Metro revised the maintenance staff schedules to accommodate all scheduled maintenance during overnight hours and on the least busy operating days. This effectively increased the number of vehicles available for service on any given day.



A new train control software system was initiated that will reduce the time between trains to 80 sec (down from 100 sec). When the new train control system is fully operational, this will increase the capacity of the system by about 10%.

## Buenos Aires, Argentina

Service optimization in Buenos Aires has been limited by financial constraints, labor union objections, and a lack of a long-term transit planning process.

Improvements to the subway system and the capital investment to pay for those improvements are the responsibility of the federal government, but once the capital investment is made, the local government owns and maintains the system. As a result of a political decision to keep fares stable rather than keeping pace with increased costs and inflation, public subsidies now account for roughly 60% of the cost of operations.

In 2000, electronic fare technology (smartcards) was introduced. Subway cars were purchased from Japan at about the same time in an effort to meet rising ridership demand. Although the cars had to be modified with skirts to bridge the gap between the platform and car (the Japanese cars were narrower than the cars traditionally used), the cars have proved to be the most reliable and cost effective in the fleet (Figure 7).

When its contract began in 1994, Metrovias assumed operation of a transit system that was stagnant and not keeping up with demand and capital



**Figure 7** Metrovias Line B “second-hand cars.”

infrastructure needs and was not viewed positively in terms of efficiency and reliability. Metrovias attempted to improve efficiency through staff reductions, but was not successful due to tradeoffs that were made to buy labor peace and accommodate legacy work rules and related issues.

Several operational efficiency improvements were considered during the past 5 to 7 years, but ultimately were not implemented. These included peak/off-peak fares, electronic fare collection, fare vending machines, and reductions in onboard train staff.

Peak/off-peak fares were considered as a means of shifting some of the crowding seen during peak periods to off-peak periods, when more capacity was available. The federal government decided not to back this initiative because of concerns by station fare collectors about conflicts with passengers about the proper fare to be collected.

Metrovias has found that the administrative costs of the electronic farecards are higher per ride than the fare collected. Fare coordination between commuter rail, subway, and bus services does not exist, despite having been a goal for many years.

Fare vending machines were also purchased several years ago but were never used; public concerns about the machines’ impact on employees, who might be displaced by the automated system, blocked their implementation.

The idea of reducing staff onboard the trains by eliminating guards who are primarily responsible for opening and closing doors met with opposition from the labor union because of a perception of decreased security on the trains and hence was not implemented.

Approximately 15,000 buses operate on the streets of Buenos Aires, with the majority operating under permits issued by the federal government. Some 3,000 operate under provincial control, with 2,000 under local control. Since 1987, the number of companies that have been granted operating permits has been significantly reduced, and those companies have operated with greater scrutiny and oversight from the government. New requirements have been put in place in which vehicle types and required features have served to improve service and even accessibility. In 1987, only one of the operating companies had more than 350 buses. Today, there are five companies of this size or greater. The number of operating companies providing service has been reduced from 120 in 1987 to fewer than 60 today.

Public buses operate on some 300 independent routes with significant overlap, but overall spatial coverage is quite good. To aid passengers in navigating the system, bus destination signs are quite large and easily read from a distance. Bus stops share poles with parking signs and list the route numbers and destinations for buses serving the stop. Equipment has improved, and a regulation that no vehicle of more than 10 years of age can be operated has recently been implemented. About 15% of the operating fleet employs a low-floor design.

Even with the challenges of a public to private transition and given the limitations placed upon Metrovias management by labor rules that serve to reduce efficiency, strides have been made in improving service and increasing efficiency. Most of the efficiencies are related to the planning and service delivery choices that have been made by Metrovias, as well as in infrastructure development. Service reliability has improved dramatically since Metrovias began operations.

### Porto Alegre, Brazil

Current service optimization projects in Porto Alegre include installation of an integrated fare system; revitalization of specific areas; improved user information at bus terminals and stops, such as maps and pocket guides; and more centralized control and monitoring. Porto Alegre is installing priority lanes for public transit in the city center and connecting with transit corridors already in place. For the BRT lines, elevated platforms are being constructed in the center of the street to improve boarding time. They are also trying to locate bus stops near area trade centers and services. In addition, an improved network of bikeways is slated to promote alternate mobility options.

To improve traffic flow, cameras are being installed to help manage traffic at intersections. At this point, 95% of the cameras are tied into the system. The traffic management system operates 24 hours a day, 7 days a week. Another traffic flow tool is signal timing, which can be adjusted to reduce congestion. All buses are equipped with a transponder (AVL system) that works with 40 antennas located throughout the city to determine if transit vehicles are operating on time.

More than 65% of the BRT lines operate through the downtown and are a major contributor to the downtown area's vitality. Improvements to the BRT

lanes are consequently being made to improve the flow of BRT buses through the downtown area.

Under the former bus system, tickets and cash were accepted as fare payment. Now, with the new electronic farebox system, every person entering the system must use a smartcard to board a bus, regardless of whether a fare is required or not. This allows information on actual usage to be collected, which in turn enables planners to evaluate travel patterns and design more efficient service.

It is expected that smartcard technology will be fully integrated into the entire system within a few years. Passengers boarding buses at stops throughout the city will have to use a farecard to access the system. Onboard smartcard readers, as well as smartcard-accessed pre-paid stations at certain busy stops, will be used to monitor and control access.

There are 5,500 bus stops in the system; some on raised platforms served by BRT lines and some on sidewalks. Some of these bus stops have considerable amounts of information for users, including maps of the network, maps of individual routes, and bus schedules. Those stops that do not yet offer this information will be upgraded to include it.

In Porto Alegre, the transit system utilizes a unique service optimization technique called *comonor*, which is a convoy type service that provides improved bus service delivery. This technique consists of six buses lined up at the transit station or bus stop into three groups of two buses, with each group headed to the same destination. For example, two buses form group A, two buses form group B, and two buses form group C. All six buses are released at the same time and they follow each other in a convoy. Passengers waiting at bus stops know the order of buses arriving and form lines that will increase boarding speed and reduce the time the bus has to be stopped for passenger boarding and alighting.

GPS technology is also being used now to more efficiently schedule and monitor bus service, and traffic signal prioritization (TSP) is being implemented. This process is made easier with the involvement of EPTC, which manages and regulates the city's entire transportation system, including traffic flow and control.

EPTC's strategy for achieving a sustainable transportation system is to make walking a priority mode, provide incentives for auto users and motorcycle riders to shift to alternative modes of transportation, and use information technology (IT) and transportation demand management (TDM) strategies to make

the most efficient use of all transportation facilities. Other key initiatives include improving the spine of the transportation system by expanding the rail network; improving the efficiency of the bus network with GPS; using an electronic ticketing system to integrate fares and minimize fare evasion and crime; building a bicycle network to encourage more travel by bike; and testing and adopting sustainable energies, including biodiesel, electric, and battery technologies.

## CUSTOMER EXPERIENCE

### Guayaquil, Ecuador

One of the key problems in Guayaquil before the introduction of the BRT service was the chaotic and unsafe bus system. There was an overwhelming and growing demand for transit services, and the private bus system could not efficiently and safely meet the demand.

Metrovia is considered to have been hugely successful. Safety has significantly improved. Crime is no longer a problem on buses. Customers are satisfied. Bus operators are pleased—they have job security, fewer work hours, and a stable income. Financial institutions are satisfied with profit making arrangements. The city is pleased not only with the improved public service, but also with its contribution to an improved state of the city. More BRT lines are planned, and, assuming continued political leadership and support, the service will be successful in meeting and managing the demand for public transit services.

The immediate effect of the initial BRT corridor was to reduce bus congestion, reduce the number of accidents involving buses, and improve travel time and access for residents of outlying areas. The city government had established a goal of removing 650 private buses from the streets by implementing the first three BRT corridors. The opening of the initial corridor, when owner-operators left the collectives to work as employees of the concessionaire operating the first corridor, resulted in over one-third of that goal being achieved. Approximately 250 private collective buses were replaced by the new fleet of 40 articulated buses and 40 standard-size feeder buses when the first corridor opened.

Metrovia receives high marks from the public; riders are pleased with the system's travel time savings, as well as the newness of the infrastructure. The positive image is further reinforced by the extensive

branding of the system. Because Metrovia's vehicles are fairly new (3 years or less), they are much more attractive than the older buses used by the private collective services. Metrovia's vehicles also do not emit clouds of exhaust, which further contributes to a positive image for the system. The branding of the system with "Metrovia" displayed prominently on buses, stations, and terminals reinforces the positive perception that the system is a time-efficient means of getting to one's destination. Ridership growth has affirmed that perception.

Accidents between BRT buses are nonexistent because of the dedicated lanes, and conflicts with private vehicles have been reduced to one or two per day. Users of the new system enjoy travel time savings of as much as 30 min from outlying areas, which was a 50% savings over the travel time using private collective buses. The use of dedicated lanes for Metrovia further improves travel time, resulting in a service that is faster than the collective buses that it replaced and competitive with driving an automobile.

### Santiago, Chile

The immediate customer dissatisfaction that occurred with Transantiago's rushed implementation brought changes that improved the customer experience and service delivery and also improved efficiency. Many other improvements have been made since then to the infrastructure and systems that support the bus network.

One major improvement was the establishment of 148 bus stops with prepaid zones to speed up boarding in some of the busiest areas. When Transantiago opened in February 2007, no prepaid zones existed, and bus loading had a major impact on travel times. The prepaid stations were added to speed up boarding; riders pay as they enter a secured area, where they wait for the bus. When the bus arrives, passengers can quickly board. Some riders still manage to evade paying a fare, but the agency is pleased with the benefits brought by the prepaid zones and is developing improvements to further minimize fare evasion.

In August 2007, the operating contracts were revised to include improved schedules, increases in the number of buses, and incentives for quality service and reduction of fare evasion. Modifications were also made to the contract with the Administrator Financiero de Transantiago (AFT), which is owned by four banks and which is responsible for administer-

ing the fare collection process. These modifications included a fleet monitoring system and increases in the number of sales outlets for the bip! card.

Oversight of the bus network was also improved, a monitoring center was established, and the temporary fleet monitoring system was used to oversee schedule adherence and to detect buses bunching on the trunk lines. The engineers communicate with the operators to document contract violations and implement service improvements.

A major public information campaign was established in 2008 utilizing radio and television. The campaign focused on a variety of issues, including publicizing route changes, discouraging fare evasion, speeding up boarding times, announcing recent improvements, and attracting students to the system.

Significant service improvements were gained through the many efforts implemented by Transantiago. The rapid improvements in the first two years of operation would not have been achieved if a more gradual change to the bus network had been implemented. Passenger dissatisfaction with the system has decreased since the initial start-up.

The average wait for a bus has been cut in half (to 5.6 min from 11.9 min in February 2007). In that same time period, the percentage of passengers waiting more than 10 min has also been halved, to 6.8% from 17.4%, and only 0.7% of passengers report waiting more than 20 min (down from 4.4%). Travel times throughout the system have improved, as has customer satisfaction with Transantiago.

The service has now stabilized at 5,800 buses (up from 4,000 in 2007) and includes an additional 3,802 km of service (6,502 km in 2007), and an additional 44.4 km (15.6 km in 2007) of exclusive bus lanes.

The number of smartcard recharging locations has increased from 558 in 2007 to almost 2,000 today.

Forty percent of daily riders use the bus system exclusively, 25% use the Metro system exclusively, and 35% use a combination of Metro and bus. Demand for Metro service keeps growing, with annual passenger trips up 6.8% over 2007; rush-hour trips increased by 10.4% over the same time period.

Accidents and complaints per million customers have also decreased significantly, and system speed has improved. With the improvements in service quality, customers are increasingly pleased with Transantiago, and the company is once again held in high public regard.

Surveys show the number of highly satisfied customers—that is, those ranking the system as either

a six or seven on a scale of one to seven—is on the rise, improving from 37% in 2007 to 52% in 2008. This is still a long way from the 81% satisfaction level in 2006, but also a great improvement over the satisfaction level in 2007. In 2009 Transantiago won awards for both service quality and reputation recovery, and the system now holds the ninth best reputation in all of Chile.

## Buenos Aires, Argentina

Improvements made since Metrovias took over operation of the system have led to a doubling of the percentage of total trips completed by rail, subway, and light rail. The Metrovias system now transports more than one million passengers daily, which has led to a 15% reduction in passengers using the bus system.

Metrovias is still making improvements to attract and retain riders. Their overarching goal is to meet increasing ridership demands while reducing air pollution and energy consumption.

Metrovias's cultural program *El Subte Vive* (The Subway Lives) mobilizes 400 artists each year, who display their art, murals, and sculptures at stations. A jazz festival is conducted at subway stations, film clips are shown in stations, and artists perform at several stations and on select trains. The program is evidence of Metrovias's support for the community and its culture, and it boosts the image of the transit system among riders.

Metrovias has been able to double its customer base through service and reliability improvements. They accomplished this by adding new lines and increasing the fleet size by 250%. Reliability of the Urquiza rail line improved 99% between 1994 and 2008, making the customer experience significantly improved. Fare payment on the Metrovias system has been improved through the implementation of a magnetic farecard system, called *monedero* (electronic purse). More subway lines are planned, and the government is focused on developing the financing for construction.

Improvements to the Metrovias system are affected by the organizational structure and working relationship between Metrovias and the federal government. Although the local government owns the assets and Metrovias operates the system, Metrovias's agreement is with the federal government. Capital improvement items are prioritized by the federal government. Each year, Metrovias has to submit

a capital improvement plan, prioritizing the most needed repairs and/or capital expenditures for approval by the federal government. The federal government reviews the plan and selects the most important projects for implementation. These projects compete with other government needs for capital improvement funds. The federal government has set policies that preclude Metrovias from raising fares, implementing congestion pricing, or providing discounts for multiple trips. The federal government also is responsible for negotiating with labor unions and setting salaries.

Bus services in Buenos Aires are still dispersed among a number of private operating companies, which often compete with one another along major corridors. Large numbers of bus operators with vehicles of differing colors and service overlap, making it difficult for the casual user to ride the bus network. To aid passengers in navigating the system, individual buses include a large easy-to-read destination sign on the front, and bus stops are outfitted with signs that clearly indicate which buses, routes, and destinations serve that stop. There has been no demonstrated need to change operations from the private sector to the public sector, because the current bus operators are providing an adequate level of service and complying with the requirements of the permit/franchise program imposed by the federal government.

## Porto Alegre, Brazil

Because motorcycles and cars are increasingly affordable to its citizens, Porto Alegre focuses on providing and promoting transportation alternatives to single-occupant vehicles. The city has adopted a goal of increasing the effectiveness of the public transit network as a means of countering the social disbenefits of increased auto and motorcycle use in order to further Porto Alegre's position as an environmentally conscious community. Marketing and customer information are a big focus, as are public awareness campaigns and efforts at improving facilities for walking and biking. EPTC also offers employers reduced rate bus passes, which can be provided in lieu of a portion of an employee's salary.

While all the systems visited on this mission offered free or discounted passes for students and seniors, Porto Alegre demonstrated the most generous policy in this regard. Groups who receive free or reduced rate passes include students, teachers, mili-

tary police officers, city police officers, postal workers, EPTC employees, transit employees, and citizens aged 65 and older.

At the same time, the transit system is challenged to sustain itself. As in other Brazilian cities, transit in Porto Alegre is expected to be self-sustaining from farebox revenue. Management is particularly concerned with the impacts of raising fares, fearing that this could cause more people to choose to drive.

Despite these challenges, the bus operators continue to invest in the system and provide an improved customer experience. Carris, a major public operating entity, has continued to purchase new vehicles and introduce more and more amenities with each purchase; today, its fleet averages 5 years. Some of the vehicle improvements have included automatic transmissions, rear engines, air conditioning, and accessibility improvements, such as level boarding for high platform stations and low-floor buses with ramps for wheelchair access. Currently, 73% of Carris's fleet is outfitted with automatic transmissions and rear engines, and 43% of the fleet has air conditioning and is accessible to those with disabilities.

The overall philosophy is to improve customer comfort to stem the loss of passengers to automobile travel. Change in the system has occurred gradually. The introduction of BRT service was initially limited to one corridor and has been gradually expanded throughout the city. Other changes, such as the introduction of low-floor buses and electronic fare collection, have similarly been implemented incrementally. Maintaining vestiges of the old system, such as the continued use of conductors for fare collection, has ensured that the system does not change too rapidly for its customers to understand and adapt to new technologies and procedures.

## REVENUE SOURCES AND FUNDING MECHANISMS

### Guayaquil, Ecuador

#### *Fares/Fare Structures/Fare Collection*

In Guayaquil, the full fare is US\$0.25, while the average fare is US\$0.235 because of reduced fares for seniors, students, and the disabled. Unlimited transfers are included in the fare. All transfers occur at designated transfer stations; therefore, there is no need for any type of documentation or transfer slip to enter a connecting bus. Fares are paid at each station as a customer enters through a turnstile.

Fare collection and accounting is outsourced to a private contractor/bank. The money is picked up by the bank twice a day at all of the BRT stations, after it has been counted by the contractor and prepared for deposit. Fares collected by the feeder services are taken to the stations for deposit and subsequently collected as part of the station activity as well.

All fare collection equipment is monitored at a centralized control facility. Computers are used to identify each turnstile at each station and its current condition. The fare collection equipment also transmits passenger counts, with reports generated daily that relay both revenue and ridership.

### *Funding/Subsidy*

A fundamental aspect of the new structure is that it does not receive any operating subsidies from the government. The system is entirely self sufficient. Passenger fare revenue is distributed to the concessionaires based on “real income” as opposed to a formula based on miles or hours of service, thus providing a high incentive for performance. It is noteworthy that the Metrovia Foundation is funded not through fare revenue, but through advertising income and property rents.

The government does, however, provide the basic infrastructure for operation. In this regard, the municipality invested \$92 million for the construction of the first three BRT trunk lines. This expenditure included the exclusive bus lanes, priority signalization, bus stops/stations, and the terminals. This was funded through municipal bonds for which the federal government pays the debt service.

The concessionaires have invested \$75.6 million to purchase the buses. This funding was privately secured, with banks providing loans of up to 60% of the cost of a bus and with a payback period of 4 years. Thus the concessionaires were required to invest at least 40% of the cost. In many cases, this revenue required for the “down payment” was generated through the sale of the old buses. In some cases, prior individual operators banded together to form a consortium, which either became the concessionaire or a part of the concessionaire.

## **Santiago, Chile**

### *Fares/Fare Structures/Fare Collection*

The fare in Santiago is equivalent to US\$0.80 with three transfers permitted within 2 hours. Fare

evasion is a serious problem despite having been reduced from 20% in 2007 to 15% in 2009. The bip! card is used throughout the system. Although the smartcard can be personalized with a picture, the card can be used by multiple passengers to gain admission into the transit system. The card costs \$4 to purchase and is rechargeable.

The electronic fare media system is administered through a private contractor that was created in 2005 to issue, sell, and administer the smartcard. In addition to selling and administering the smartcard, the contractor (AFT) acts as a clearinghouse for the transit fare revenue. As such, the contractor is in charge of general revenue collection and the administration of resources and payments to the rest of the Transantiago system. The contractor is responsible for the procurement, installation, and maintenance of all onboard collection equipment. The contractor is also accountable for daily ridership and revenue data.

### *Funding/Subsidy*

The majority (90%) of the current general revenue comes from fares; the remaining 10% comes from advertising and other sources. Capital projects are funded at 67% by the federal government, with a 33% local match. The structure launched in 2007 envisioned self-sufficient operation of the transit system; no operating subsidies from the government were expected.

However, the poorly executed operational aspects of the system negatively affected the bottom line as well. Therefore, some loans and subsidies have been provided by the federal government for short-term financing. The current subsidies decrease annually and are scheduled to sunset in 3 years, at which time the system needs to be self-reliant, or new subsidies will have to be approved at the federal level.

The financial problems underlying the need for a subsidy are a result of overestimated revenue and underestimated costs. Revenue deficits were primarily caused by fares that were insufficient, free transfers, extended transfer time, and passenger fare evasion. Contributing factors for the cost increases included technology that failed to optimize operations, poor route and schedule planning, incomplete infrastructure, and additional vehicle requirements.

Fare revenue is disbursed to the service providers based on ridership, but at a scaled level. The per passenger payment decreases as the number of passengers increases beyond a set level. From a practical standpoint, the operators receive the per passenger

payment plus a subsidy to make them whole. The subsidy is based on actual expenses compared with projected contract expenses.

## Buenos Aires, Argentina

### *Fares/Fare Structures/Fare Collection*

The fare in Buenos Aires is approximately US\$0.25; this subway fare is one of the lowest in the world, according to Metrovias staff. Government regulation has kept fares artificially low over the past 10 to 15 years as a result of the economic difficulties experienced in Argentina. Also, discounts and/or free rides are provided to students and seniors of low income. Transfers between bus, rail, and subway are common, but require a separate fare for each mode.

Electronic fare media, used by 60% of the riders, is the most popular form of payment. Magnetic tickets are also available in single and 10-ride form. Because of a coin shortage, the government imposed a cashless system in 2009. The smartcard is in the process of being expanded to all public transit, thus moving the system to a regional universal farecard. The electronic fare system provides accurate ridership figures for the bus system. Access to the subway system is granted through turnstiles, which also facilitates ridership counts.

### *Funding/Subsidy*

Currently, government subsidies for the transit system have reached approximately 60% for rail and 50% for buses, which is a long way from the intent of the privatization concept implemented in 1994. It is particularly significant considering that from 1998 to 2004, the system not only did not require subsidies, but also saw a positive cash flow back to the government from the concessions.

The federal operating subsidies are funded primarily through gas and oil taxes and are mainly disbursed based on ridership volumes per km. Also, the transit service providers only pay 30% of the market cost for gasoline used in operations.

Capital funding for new rail lines is provided through the sale of federal land, while infrastructure for existing lines was specified as a contractor responsibility in the original bid documents. However, because of the changes imposed by the government and the economic environment, a capital improve-

ment plan is submitted to the government as part of its annual budget process. The World Bank has also provided loans to fund the system.

## Porto Alegre, Brazil

### *Fares/Fare Structures/Fare Collection*

The transit fare is approximately US\$1.25, while the average fare is significantly lower at nearly US\$0.86. This discrepancy is the result of discounts offered to students, teachers, justice workers, and others, and free rides are given to a host of groups including the elderly, military, postal workers, and municipal workers. Free rides are also provided to some individuals based on income, while everyone enjoys free rides on 6 days annually.

Most fare collection is accomplished through an electronic system that was introduced after a history of token usage. Most (85%) customers pay with an electronic farecard; the others pay cash to an onboard “collector” who makes change and operates the vehicle turnstile. The widespread use of the farecard indicates general acceptance of and satisfaction with the electronic system.

The electronic fare system, or *transporte integrado*, is a joint venture of the transit system oversight agency and the consortium. The electronic media, known as “tri,” was implemented with the objective to achieve more accurate passenger counts, reduce fare evasion, improve transfers, and increase safety. The information generated from the system is invaluable to operations as it is utilized for more thorough analyses of customer demand, which helps to optimize route scheduling and plan service changes.

### *Funding/Subsidy*

The transit system does not require any government subsidies, as the recovery ratio is designed to balance fares with costs. Fares are reviewed annually for readjustment on the basis of a formula that considers cost/mi and passengers/mi, with costs including both fixed and variable. Moreover, the fare is automatically increased if inflation exceeds 8%.

The management of compensation to the individual contractors is a responsibility of the consortium. It accounts for daily revenue, which is distributed on the basis of a percentage of the total ridership and the miles of service delivered.

## CONCLUSION

This mission provided a window into various approaches to transit service planning and delivery taken by four cities in South America. Each location had unique challenges in managing increasing transit ridership demand as an important method of addressing urban growth and mobility problems.

### Government, Political, and Labor Influences

Government and political influence varied greatly. In Guayaquil, the city's mayor was the agent for overall change, as he personally supported BRT as the solution to traffic congestion and other problems in the city. The mayor was seen as a hero for transforming the bus system, which contributed to the city's significant economic progress.

Santiago has a more limited role for local government, and transit planning was often influenced by politicians at the federal level. Santiago's experience with the rushed implementation of Transantiago is a cautionary tale of how the image of transit can be damaged when a new system is opened before it is fully ready. When the system failed because not all necessary elements were in place on opening day, the leadership of the city and of Transantiago stepped up to devise and implement improvements to quickly address the problems.

Buenos Aires provided an example of a subway system where the infrastructure was primarily owned by the city and managed by a concessionaire, but where the true decision-making takes place at the federal level. The federal government is also involved in bus services in Buenos Aires, issuing the permits/franchises for each set of routes and determining performance standards, such as the maximum age of equipment and minimum headways.

Porto Alegre is perhaps more similar to Guayaquil, where decision-making is primarily at the local level, with a bit more influence from state and federal government than in Guayaquil.

In Guayaquil, the publicly sponsored Metrovia system was very careful to bring the owner-operators of the privately run collective services into the new organization. While initially perceived as a threat to the private operators, Metrovia succeeded in making the private operators stakeholders in the new system, thus mitigating the perceived threat. Having the private operators become part of the new system made

it easier to develop the second BRT corridor, as the operators knew what to expect.

Santiago had a different experience with labor upon opening the Transantiago system. Bus operators were employees of the concession companies who were under contract to Transantiago. In Santiago, bus operators were initially overwhelmed by the great number of new passengers, and they had a lack of knowledge as to how the new routes and schedules worked. Some of the concessionaires provided little or no street supervision, especially during late evening hours, and some service was not operated as scheduled because the operator simply chose not to. More direct supervision and better route and schedule information for bus operators has improved the situation.

Buenos Aires's Metrovias subway system has a long history of labor unrest. This became evident during the mission when there was a one-day strike over an issue that management had no control over. Organized labor sought to get the attention of the federal government, not the concessionaire (Metrovias). The role of organized labor is also evident in that efficiencies such as fare vending machines and elimination of conductors (guards) on trains has been successfully blocked by the unions.

In Porto Alegre, the role of labor is less pronounced, yet there are indications that protecting jobs, even for an outdated function, has been deemed important. One indication is the continuing use of conductors onboard the buses, despite 85% of fare transactions being electronic. Another indication is the degree of manual operation of some elements of the electronic fare collection, where passengers must travel to a central downtown office to add funds to their farecards.

### Transit Delivery Systems

The use of private-sector companies at various levels of each operation (i.e., for fare collection services, fleet maintenance, service delivery, and quality control and assurance) seems fundamental in each city as a means of improving efficiency and accountability.

In Guayaquil, all operations are outsourced by the Foundation—biases are thus minimized when regulating performance. The pure structure of the Foundation has allowed Metrovia to gain and maintain the trust of all involved parties, including customers, the



government, financial institutions, and bus operators. Their ability to maintain honesty and objectivity is directly linked to their effectiveness as the system manager and to the successful operations of the Guayaquil system.

The Metrovia BRT system has proved a worthwhile investment for the city of Guayaquil. The original objective to improve service was met; travel times have been reduced, the number of accidents involving buses has decreased, security has increased, fares are affordable, buses are newer, the transit infrastructure is more cohesive, and customer service has improved. There is a very high level of public acceptance of Metrovia, and the public has given Metrovia very high marks for its efforts to improve the quality of life in the city.

The new system brought higher than expected benefits to the bus operators—better legal and financial guarantees, employment security, and continued enterprise opportunities with more organized and profitable businesses. The overall result was an improvement in the quality of life for all.

The Metrovia BRT stations and terminals were designed for future levels of demand, not just what was expected as each element of the system opened. Service currently operates on 5- to 10-min headways, but the availability of dedicated lanes means that greater frequencies could be achieved without having to expand infrastructure. Stations and terminals were also designed to accommodate greater volumes of passengers without any modifications.

Metrovia has opened up new economic opportunities for many residents and has reduced travel times, thereby improving quality of life. Urban revitalization and economic development, although not a primary goal, is clearly evident. Neighborhoods on the outskirts of the city that previously had poor access to the center of the city now can reach the city center through the combined BRT and feeder network. The Metrovia system has spurred economic development around its stations. New sidewalks, parks, and plazas have been built, shopping and commercial areas have emerged, and pedestrian walkways have been constructed to link the commercial areas to the stations.

In Buenos Aires, one of the major challenges for the subway system is how to balance an aging infrastructure against not only increasing ridership, but also an institutional framework that limits the system to merely attempting to maintain the status quo with respect to capital investment, revenue streams, and labor relations. The federal government has a large

share in the operation of the subway, and 60% of operating costs are provided by federal subsidies. This investment has resulted in labor unions bypassing the Metrovias management and going directly to the federal government when they have an issue about work rules or conditions. The role of Metrovias staff has transitioned from a management concession to one of making sure the service runs every day. System improvements and extensions are subject to the approval of and funding from an annual capital improvement program, rather than a long-term planning process.

Bus services in Buenos Aires are still dispersed among a number of private operating companies that often compete with one another along major corridors. There has not been a demonstrated need to change operations from the private sector to the public sector, as was done in Guayaquil and Santiago, because the current bus operators are providing an adequate level of service due to the requirements of the permit/franchise program imposed by the federal government.

Argentina, and Buenos Aires in particular, has experienced much in the way of economic uncertainty. A well-intentioned plan to improve the overall quality of transit service to the community has not worked as well as expected. However, the structure in Buenos Aires provided a significant improvement in organization and modernization that directly benefited the customer. By combining private and public resources and assets, it created a better system of public transit.

The transit system in Porto Alegre is an example of a successful PPP. Most interesting is that many of the players are the same as in the prior system, but with stronger organization and oversight. The consortium concept has brought much needed discipline and control to the system without sacrificing individuality, accountability, and responsibility. The fact that the public operator, which was allowed to remain and is a part of the team, is considered to be the best operator in South America, is a telling statement of the achievement of this structure.

Porto Alegre has pursued an enhanced bus network with BRT operations in many corridors as an alternative to a large rail investment. While there is rail service, it is limited to one corridor and only carries about 14% of the total transit ridership in the city. Porto Alegre's bus network features a unique partnership between a publicly owned operator and three private concessionaires to offer an integrated

service to the entire metropolitan area. Because of Porto Alegre's prosperous economy, automobile ownership and usage has been increasing, with the result that between 2000 and 2004 the bus system lost ridership; a small percentage of the loss has been regained since then.

An EPTC manager in Porto Alegre said, "We're not interested in what's right; we're interested in what's wrong," in reference to advanced technological tools that allow them to monitor all aspects of concessionaires' performance against prescribed service standards. This method not only protects the quality of the product (e.g., on-time performance, standards of maintenance, driver hours, number of security incidents, wait times at ticket sale outlets), it also produces significant revenue. When concessionaires fail to meet agreed upon standards, they are fined, and the revenue are used to fund the system. Sophisticated technology for monitoring performance and an intricate fines/penalty system were common to all host cities.

Mobility management is necessary to achieve an integrated multimodal system, and it involves fare integration, coordinated service plans, and good intermodal connections. In Porto Alegre, EPTC's mission is transportation as mobility management. EPTC staff are focused on investing in and utilizing the whole transportation network to move people in a sustainable way, and it appears to be effective. They have the power to regulate and enforce. The enforcement enables EPTC to override self-serving intentions. In contrast, many agencies in the United States that have adopted policies to take on the role of a mobility manager are not empowered by law to regulate and enforce.

## Customer Experience and Perception

One indication of the success of the systems visited on the mission is how well they are perceived by the residents of each city.

Overall, customer satisfaction is very high among all four systems. In Guayaquil, customer support for the system largely developed because the Metrovia BRT system is faster and safer than other modes of transportation, including the private collective buses that it replaced. Residents also perceive Metrovia as rapid transit, not just a bus system, and therefore a source of pride for the city. Because the BRT service was implemented in phases, people had time to become accustomed to the system.

Santiago introduced major changes in the city's bus system all at once, bringing about a major cultural change in how residents used public transportation. While any major change would be troubling enough for riders, insufficient capacity together with insufficient public information undermined the public's confidence in the new system. Many bus riders turned to the highly regarded Santiago Metro instead, immediately overwhelming the Metro and causing a further erosion of public confidence in all modes of public transportation. When the new electronic fare collection system did not function properly, further adding to the chaos, the public's discontent got the attention of the politicians, who decreed that steps had to be taken to turn the system around. Because of strategies developed by both the bus and rail systems, public confidence has been regained.

Equipment requirements were underestimated in Santiago, and there were not enough exclusive bus lanes to give the buses travel time advantages. Information about the changes in the new system was not available, the public was confused about how to use the system, and the bus drivers did not have an understanding of new routes and transfer points.

In Santiago, accepting accountability for the mistakes seemed to be the key to solving them. Prompt corrective action by the transit system and the city addressed the deficiencies, leading to improvements in service and satisfaction. Passenger surveys conducted since the system's inception in 2007 report significant improvements in user satisfaction.

The Santiago Metro has also been able to recover from negative public perception as a result of its inability to handle crush loads of riders who were displaced by the unsatisfactory start-up of Transantiago. Through operational efficiencies, including skip-stop express service and short-turn trains, Metro was able to offer more service in the segments of its system with highest demand. Today, although Metro is still busy, ridership can be better managed. Greater reliability in the Transantiago bus system has resulted in shifting some riders back to the bus system, relieving some of the surge that Metro experienced.

The Buenos Aires subway operated by Metrovias has a high degree of public support. Most residents recognize that the subway only reaches a small percentage of the metropolitan area and that the system is overcrowded, but the subway, the oldest on the continent and one of the oldest in the world, is a source of pride among residents. Improvements are slow in coming, as the subway and commuter rail system has insufficient funds for expansion.

Commuter rail services in Buenos Aires are operated by different concessionaires. The provision of more modern equipment on the Urquiza commuter rail line (refurbished) and the San Martin commuter rail line (new and refurbished) is highly regarded by the public and contributes to the positive public perception of these lines.

In Porto Alegre, residents feel that the city has a modern and relatively efficient BRT network that has evolved over time. In a manner similar to that in Guayaquil, the BRT system has been expanded gradually, without any sudden and widespread changes to residents' travel patterns. The positive perception of public transit in Porto Alegre has been helped by the investments that Carris, the major operator, has made in new low-floor and air-conditioned buses that also provide better ride quality and environmental benefits due to newer, cleaner engines. The reputation of Porto Alegre as a progressive city has also encouraged the use of public transit, providing evidence that the residents are responding to environmental concerns.

To counter security concerns and problems with fare evasion, armed security personnel are highly visible on these systems.

Fare structures that are easy to understand contribute to positive customer experience and support.

There appears to be support for service that costs more but that also provides a more comfortable ride for the passenger.

Any changes to systems should be approached with lots of careful planning and education campaigns to inform both customers and employees of the upcoming changes.

## Technology and Service Optimization

### *Technology*

All four cities have introduced technology as a means of better managing demand, whether by electronic fare collection or by vehicle locator systems based on a network of cameras and control centers that oversee traffic “hotspots.”

All of the cities visited used technology to enhance their operations. Guayaquil, Santiago, and Porto Alegre use sophisticated camera surveillance systems and control centers to manage traffic operations and maintain reliability in their bus operations. The subway systems in Santiago and Buenos Aires also use camera systems, but these are intended more for safety and security.

Electronic farecard systems have been adopted by all four cities with high acceptance among the traveling public. In Santiago the only method of fare payment on the bus is by farecard, but the other cities, where riders can opt to pay in cash, have impressive farecard usage rates (60% on the subway in Buenos Aires and 85% for the bus system in Porto Alegre).

Improvements in fare collection technology, increased emphasis on the use of dedicated bus rights-of-way (such as with BRT), and a growing reliance on intelligent transportation systems are additional methods allowing cities to address the problem of delivering more transit service with fewer financial resources in a safer and more reliable way.

### *Service Optimization*

In Porto Alegre, to make the bus system more attractive and to retain riders, the city and the transit operators have invested in infrastructure and technology to make the buses more competitive with automobile travel. These improvements include new buses with amenities such as low-floor boarding and air conditioning, dedicated bus-only lanes as part of BRT operations, better public information, electronic fare collection, and a camera-based traffic monitoring system.

In Porto Alegre, the *comonor* platooning system allows for more bus service while reducing congestion. Passenger knowledge of how this system operates allows boarding times to be shortened, resulting in increased service efficiency.

Increasing ridership seems to be easily accommodated in systems with BRT corridors that operate in dedicated busways, with stations located in the center of the street. Additionally, safety is often ensured on these systems with attendants present to provide customer service.

Several systems provided multimodal stations, bus stations, or terminals that offer amenities useful to riders and allow for easy transfers between modes. Examples of some amenities and alternate uses found in stations include retail businesses, restaurants, art displays, gyms, and lending libraries.

## Managing Increased Demand with Limited Financial Resources

With limited resources and the challenges of being financially self sustaining through fare-box recovery, there seemed to be an emphasis on methods to speed up transit service and provide addi-

tional capacity. Whether by reducing the time vehicles spend at stations and platforms with faster boarding techniques or applying traffic signal prioritization, each city recognized that increasing the overall speed of the transit mode was paramount to reducing cost and increasing capacity.

Overall, funding for capital improvements in all four cities was very limited. In most cases, transit is still expected to be funded solely from farebox revenue. While the bus systems in Guayaquil, Santiago, and Porto Alegre are able to purchase new vehicles using the revenue stream generated from fares, the rail systems in Santiago and Buenos Aires face greater capital funding challenges for expanding and renewing their capital elements.

All three BRT systems have benefitted from the local, state, or federal government guaranteeing the bulk of the capital costs associated with BRT infrastructure, such as dedicated lanes and station stops. Generally, federal or state government funding for public transit has been constrained by competing demands, not only from other cities, but also from rural areas. In Guayaquil, external sources have been used to secure funds for initial construction, including loans from the World Bank.

One element that works in favor of the various bus agencies funding equipment purchases out of revenue is the comparatively low cost of an articulated transit bus in Latin America. The transit agencies visited by the study team reported being able to purchase an articulated bus for a significantly lower price than in the United States (approximately US\$286,000). It should be noted that buses used by these systems do not typically include amenities commonly found in the United States, such as air conditioning and wheelchair lifts, and seats tend to be more modest. While Guayaquil and Santiago use articulated buses extensively, they are less common in Porto Alegre.

The transit vehicles seemingly serve their purpose and are extensively used; the replacement cycle tends to average 8 to 10 years, unlike the 12-year year lifespan found in the United States. This means fleets are renewed more often, requiring a greater dependence on farebox revenue. At the same time, transit officials are very conscious as to their passengers' inability to afford higher fares. Renewing bus fleets using farebox revenue has not generally been a problem, except in Guayaquil, where renewal of the BRT fleet in the future is a concern, and funding may be sought from outside sources, including the World Bank.

For the rail systems in Santiago and Buenos Aires, capital funding is constrained, in part, due to the relatively high cost of rail cars and infrastructure. Santiago has been fortunate to have a more modern subway system, so the infrastructure is newer. As noted earlier, Santiago has employed techniques such as short-turning trains during peak periods to provide more service over the most heavily used portions of the system. Buenos Aires has a much older system and has not implemented this technique due to a lack of turnback locations. Buenos Aires also has much older rolling stock on its subway, and on some lines, a limited number of cars means that longer trains cannot be run to accommodate higher demand. Capital funding comes from the federal government, and competing interests at the national level means funding for rail infrastructure renewal is limited.

A manager at EPTC in Porto Alegre used the expression “we operate on the edge of the blade” to describe the challenge of providing transportation services with little or no public subsidies. If ridership, advertising revenue, or penalties and fines decline, expenses must be adjusted immediately. When the federal government passes new laws regarding emissions or accessibility, fares and/or expenses must be adjusted to accommodate the resulting increased costs.

In Guayaquil, despite the success of the Metrovia system, it remains unclear as to how quickly it will be able to implement its full service plan. Although the city leaders would like to expand the BRT system to ultimately include all seven lines as planned, securing funding is seen as a critical impediment to future expansion. The first corridors were funded by loans from agencies such as the World Bank. It is not yet clear if the city will continue to be eligible for those loans, and it lacks the capital to expand the system on its own. Another concern is the renewal of the original infrastructure and equipment. Although the vehicles are only 3 years old, they are so intensively used that they may not last more than 6 or 7 years before they need to be replaced. Concern has been expressed that the revenue stream from fares is not sufficient to allow the concessionaires to purchase new vehicles, and the city has stated that it will not fund the purchase of buses. The bus lanes, stations, and fare collection equipment are fairly new, but like any fixed guideway system, these elements will require renewal at some point in the future.

## APPENDIX A—STUDY MISSION TEAM MEMBERS

(Affiliations listed were current at the time of the study mission.)

David Armijo (*Team Leader*), Chief Executive Officer, Hillsborough Area Regional Transit, Tampa, FL

Virginia T. Barry, Director, Service Analysis & Scheduling, Central Ohio Transit Authority, Columbus, OH

Ronald Downing, Principal Planner, Service Development, Golden Gate Bridge, Highway and Transportation District, San Rafael, CA

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Maureen McCarthy, Community Relations and Marketing Manager, Whatcom Transportation Authority, Bellingham, WA

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Kathryn Harrington-Hughes (*Mission Coordinator*), Manager, International Transit Studies Program, Harrington-Hughes & Associates Inc., Easton, MD

## APPENDIX B—HOST AGENCIES

### Guayaquil, Ecuador

*Fundacion Municipal Transporte Masivo Urbano de Guayaquil*

Ing. Leopoldo E. Falquez, Gerente General

Ing. Frederico von Buchwald, Presidente

Ing. James Casteline M., Coordinador de Operaciones

### Santiago, Chile

*Metro de Santiago*

Clemente Perez Errazuriz, Presidente del Directorio

Hernan Vega Molina, Gerente Administracion y Finanzas

Jamie Adasme Araya, Gerente Operaciones

*Subus*

Andres Ocampo B., Gerente General

Rafael Solano A., Gerente Unidad de Negocio

*Gobierno de Chile, Ministerio de Transportes y Telecomunicaciones*

Alvaro Velasco Espinosa, Jefe Unidad de Desarrollo Organizacional; Coordinacion Transantiago

### Buenos Aires, Argentina

*Subte Urquiza*

Lic. Ester Litovsky, Strategic Planning Manager

*Benito Roggio transporte—BR-t*

Ing. Sebastian Anchano, Gerencia de Planeamiento; Estrategico

Lic. Noelia Burgos, Gerencia de Planeamiento; Estrategico

*Ministerio de Planificacion Federal, Inversion Publica y Servicios*

Dra. Gabriela A. Stortoni, Jefa de Gabinete, Secretaria de Transporte

*Consultant*

Jose A. Barbero, Estudios y Proyectos de Transporte

## Porto Alegre, Brazil

*Empresa Publica de Transporte e Circulacao*  
S.A.—EPTC

Dr. Eng Emilio Merino, Gerente de Projetos Estrategicos em Mobilidade

Sergio Marinho Lopes da Silva, Diretor de Transito e Circulacao

Eng Marcio Saueressig, Coordenador de Regulacao de Transporte, Gerente do Programa Cidade Acessivel

Fernando Dutra Michel, Secretaria Municipal dos Transportes Substituto; Director de Transportes

Lucas Barroso, Journalist

*Associacao dos Transportadores de Passageiros—ATP*

Luiz Mario Magalhaes SA, Gerente Executivo

Francis Rauber, Subgerente de Projeto TRI—Transporte Integrado

*Viacao Pelicano*

Magnus Aurelio Isse, Diretor,

## Sudeste

Sudeste Transportes Coletivos Ltda.—Tito Fabio Schmidt, Diretor

## APPENDIX C—ABBREVIATIONS

AFT—Administrator Financiero de Transantiago

ATP—Association of Transportation Providers of Porto Alegre, Associacao dos Transportadores de Passageiros

AVL—automatic vehicle location

BRT—bus rapid transit

CCTV—closed circuit television

EPTC—Empresa Pública de Transporte e Circulação

FTA—Federal Transit Administration

IT—Information Technology

Metro—Metro de Santiago

PPP—public-private partnership

TBA—Transportes de Buenos Aires

TDM—transportation demand management

TRB—Transportation Research Board

TSP—traffic signal prioritization

TVM—ticket vending machines









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