

CITYWIDE TRANSIT INTEGRATION IN A LARGE CITY: THE CASE OF THE INTERLIGADO SYSTEM, SÃO PAULO, BRAZIL

Word Count: 6,129 + 3 Tables + 2 Figures = 7,379

Submission Date: November 15, 2008

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ABSTRACT

The Interligado System is a large scale transit modernization plan for the Municipality of São Paulo, which optimized bus routes and services, through featuring: advanced technologies for fare integration, bus fleet renovations, new requirements to the companies delivering transit services, and support infrastructure for buses (priority and exclusive lanes, bus stops, integration terminals, and user information and control systems).

The implementation of the Interligado System constitutes a very large planning and implementation effort, involving 39 private bus providers, cooperatives of 6,000 self-employed van operators; and 13,700 vehicles. Electronic farecards (Bilhete Unico) allow the combination of lines within a 2 hour time period. Integration of municipal bus services was completed in May 2004. Integration with Metro and state buses was completed in 2006. The name Interligado is no longer used to brand the transit reform, but the project components not only remain in place, but have been upgraded over time.

The main outcome of the reform has been an increase in public transportation usage within the City of São Paulo. Transit trips grew 15% and boardings 49% between 2002 and 2006. The temporal integration scheme has changed the way passengers select the combination of services and has resulted in travel time and cost savings.

Users received well the operational improvements in the priority corridors Passa-Rápido. Nevertheless, the overall rating of municipal buses declined. Main complaints were high level of pollution, long waiting and travel times, and congestion.

The paper presents a description of the city context and project implementation, an assessment of the planning, implementation and operational issues, recommendations and lessons learned.

TRANSIT SYSTEMS INTEGRATION

Transit operations could be integrated at three levels: operational, physical and fare. Operational integration involves the coordination of routes, itineraries and frequencies. Physical integration entails the creation of facilities to streamline the transfers, including terminals with paid areas. Fare integration involves the use of the same media to validate payment (e.g. paper or electronic farecards), and the provision of discounts or free transfers between services.

Integration improves the user experience by reducing the burden and costs of transfers. It makes public transportation more attractive. Integration also allows for better route planning, as services could be optimized using grid and feeder-trunk (hub-and-spoke) designs. Service optimization reduces the costs for the transit agencies and negative externalities in energy consumption, pollutant emissions and congestion.

Transit systems integration is not common in developing cities: services provided by different public agencies (bus, metro, train), private operators and individuals (informal paratransit) are delivered without coordination due to institutional, legal and financial barriers. This paper evaluates a fairly successful case of transit systems integration in a megacity.

CITY CONTEXT

São Paulo is Brazil's main commercial, financial, and industrial centre, and the largest South American city. The São Paulo Metropolitan Region (SPMR) has about 18 million inhabitants (10% of Brazil) spread across 39 municipalities (SMT, 2003). The city of São Paulo is the main municipality with 10.4 million inhabitants and an urbanized area of 900 km². The City of São Paulo is responsible for 13.7% of the Brazil GDP. Household average income is 518 dollars per month; 68% of the population has an income less than 500 US dollars per month (1); around 10% of the income is spent in transport.

Daily trips in the Metropolitan Region were estimated to be 30 million in 2001, 67% in motor vehicles (2). About 53% of the motorized trips were in public transportation (formal transit, informal paratransit and taxis) and 47% in private vehicles (1). The distribution of responsibilities in formal transit is presented in Table 1.

Table 1
Distribution of Responsibilities in Public Transport between the State Government and the Municipality of São Paulo

State Government	Local Government – Municipality of São Paulo
The Metro System: 59 km, 1.7 million passengers per day (18%)	Urban Bus System SPTrans: 5.7 million passengers per day (62%)
Regional Railroad System CPTM: 250 km, 0.6 million passengers per day (7%)	
Regional Bus System EMTU: 1.2 million passengers per day (13%)	

Source: (1, 2)

A history of transit improvements

São Paulo has been a transport pioneer in Latin America with the introduction of a state of the art Metro system in the late sixties. The Metropolitan region also has a regional rail network as well as professionally managed traffic operations scheme through CET (Companhia do Engenharia do Tráfego). It has introduced private automobile restrictions in the extended city centre to reduce congestion using plate numbers (Rodizio), and promotes non motorized transport (bikeways and pedestrian facilities).

The city introduced several priority measures for buses since 1975 (3). A total of 39 km of segregated tracks for buses were in operation as 2001 (4). One of the most important corridors was 9 de Julho – Santo Amaro (1977) with 11 km of longitudinally segregated bus lanes. The corridor featured very high bus traffic flows (220+ buses per hour during peaks), high passenger throughputs (18,000 to 20,000 passengers per hour), and commercial speeds of about 20 km/hour (5) This busway was very effective in terms of ridership, station design, and operating speeds (3). Nevertheless, it resulted in adverse environmental and land use impacts over time; emissions were very high due to the use of diesel buses and the busway created barriers to cross-corridor movements and community integration (3).

Conditions prior to project implementation

Transport conditions were critical due to high travel times and high rates of accidents and emissions. The situation was further deteriorated with the increase in auto ownership and use, and the decline of public transport service quality (6).

To overcome the situation the Secretary for Metropolitan Transport (STM) of the State of São Paulo prepared the Integrated Urban Transport Plan (PITU 2020, 4). The plan is capital intensive: construction of 284 km of metro lines (USD 22 billion), a rail line connecting two airports (USD 0.9 billion), and 265 km regional rail lines upgrade (USD 1.3 billion). The difficulties in funding the projects under PITU 2020 and the urgency to improve public transport conditions, as well as political differences between the government of the State and the Municipality, lead to the Interligado Project in 2001.

PROJECT DESCRIPTION

The Interligado System is a municipal initiative that sought the optimization of bus services through the following transport engineering principles (4):

- Services should complement each other.
- Services should be segmented according to the market needs (local, structural, central), with a clear basic structure.
- Technology should be used to enhance service delivery.
- All services should be managed in an integrated way.

The integrated solution includes the following elements (4):

- Recuperates the government's responsibility to regulate, to organize and to control transit service delivery.

- Builds an adequate legal basis for improvement, modernization and primacy of urban public transportation.
- Implements a fare collection technology that makes it possible a unique and integrated public transportation network.
- Inclusion of autonomous transport providers in the regular services under municipal oversight.
- Segregation of bus services from the general traffic, reserving space for bus circulation.
- Use of information technology for monitoring and control of the bus services.
- Definition of a new profile for the structural corridors seeking urban environment improvements and increase of property values in their area of influence.

System implementation included passing new municipal legislation: a new transport act (Lei dos Transportes 13.241 13/12/2001) that establishes the principles for the system, set up the conditions for a new bidding process for transport services, allows the autonomous transport providers to participate and indicates the responsibilities of the public and private agents involved; and the land use strategic plan (Plano Diretor Estratégico do Município do São Paulo, Lei 13.430 13/08/2002) includes the public transport network as one of the four structural components of the urban area, which gives precedence to public transportation over general traffic and generates instruments for funding infrastructure for the public transportation system (4).

The system was envisioned as a network of segmented services:

- Structural subsystem: Principal city corridors. Provides municipal macro-accessibility. Integrates various regions of the city.
- Local subsystem: Provides municipal micro-accessibility. It has two prime functions. The first is to distribute the transport offer attending the internal, short trips of each region area. The second function is connecting the passengers with the structural subsystem- transfer stations or terminals.

The city was divided into 9 regions, each one operated by one company. The local services are operated by cooperated independent drivers (formerly self-employed van operators or “Peruveiros”). The central area is served by all the companies of the structural subsystem. Transfers are allowed on terminals (physical integration on enclosed paid areas), on transfer points on intersections (virtual integration) and at any station.

The new scheme of operations reduced the municipal bus routes in the structural subsystem from 829 in 1998 to 584 in 2004, and the bus fleet from 10,956 in 1998 to 8,473 in 2004 (7). Local services are provided by former autonomous service providers with a total fleet of 4,616 micro and minibuses (7).

Total trips in the Interligado System in May 2006 were 6,06 million per day, compared with 5,25 million per day in 2002 (a 15% growth, 8). Total bus boardings, increased from 6,16 million per day in 2002 to 9,16 million per day in May 2006 (49% growth). Electronic integration is mostly responsible for the growth in boardings, which include transfers. Terminals handle 15% of the transfers. The temporal integration scheme has changed the way passengers select the combination of services, and has

resulted in lower travel time and reduced cost (8). Previously, many users had longer journeys connecting distant terminals in order to pay a single fare.

The name Interligado is no longer used to brand the transit reform, but the project components not only remain in place, but have been upgraded over time.

System Infrastructure

System infrastructure includes three priority schemes for buses: *Passa-Rápido*, *Expresso Tiradentes (Paulistão)* and *Via-Livre*. Corridors with different treatments are connected to each other and with local services at terminal stations. Passengers can also make connections between different services in open transfer facilities (at intersections) using electronic farecards. The physical scope and the estimated investment are presented in Table 2.

Table 2
Summary of the Interligado System Scope and Investment

Component	Units			USD Million		
	2001-2004	2005-2008	Total	2001-2004	2005-2008	Total
Electronic Fare Collection System				62,66		62,66
Terminal Facilities	14	18	32	59,69	104,50	164,19
Transfer Stations	25	303	328	2,63	31,58	34,21
Passa-Rápido (31 corridors – median)	94,6 km	226,1 km	320,7 km	117,83	210,76	328,59
Expresso Tiradentes ¹ (Fully Segregated)		31,8 Km	31,8 Km	158,6 ²	79,60	237,89
Via-Livre (30 corridors – curbside)	77,7 km	126,0 km	203,7 km	7,28	22,01	29,29
Monitoring and Control				32,28	48,24	80,52
Total				440,97²	496,38	937,34

Source: (4) Exchange rate 2.85 brazilian reales per US dollar (January 2004).

1/ Expresso Tiradentes was formerly named Paulistão ad Fura-Fila. Initial operations started in March 2007 (7)

2/ Investement includes infrastructure built before 2001 R\$ 140 million when the project was named Fura-Fila (7)

Passa-Rápido

Passa-Rápido corridors are median busways separated from general traffic by road markings (a wide white strip) with bus stops on the left hand side (4). Invasion of general traffic and incidents are controlled using advanced technologies (closed circuit TV cameras and advanced vehicle location using GPS). The *Passa-Rápido* busways are

geared to be more aesthetically pleasing than those built in the previous two decades, while still being able to carry large passenger volumes (they are defined as medium capacity transit corridors). System operation is open, that is, buses can feed in and out from the busway. Where median busways are not possible due to local right of way constraints, the operation is on the curb side.

Thirty one corridors with a total length of 321 km were intended to be converted into *Passa-Rápido* corridors according to the Interligado Plan (4). Eight corridors with a total length of 95 km were completed by 2004 at a total cost of R\$ 336 million (USD 117 million). The remaining investment was estimated in R\$ 601 million (USD 211 million, or 1,25 million per km) for the years 2005-2008 (4).

Expresso Tiradentes (Paulistão)

The *Expresso Tiradentes* (formerly Paulistão and Fura-Fila) is a fully segregated facility, initially intended for light vehicles on tires (Veículo Leve sobre Pneu VLP). The system was envisioned as an intermediate mode between bus corridors and metro using guided trolleybuses. Nevertheless, the VLP had several problems resulting in increased costs and reduced performance and normal buses are used instead (4).

The fully segregated corridor is a 31,8 km long from downtown São Paulo (Dom Pedro II) to *Cidade Tiradentes* (7), with 29 stops, 4 terminals, 8 transfer stations. The project includes two elevated sections with 5 km and 1 km, respectively (7). It is expected to carry 350,000 passengers per day when completed. The system use diesel-electric hybrid buses (15 m) and articulated buses. The project includes integration with Metro, CPTM trains, several corridors of the municipal bus system and the local services in east São Paulo. Initial operations of the first section (8 km) started in March 2007 (7).

Total cost of the infrastructure for the system is estimated in R\$678 million (USD 237 million, equivalent to 7,48 million per kilometer). The initial investments (named Fura-Fila) were R\$ 140 million in 1997-1999. Additional investments in 2001-2004 were R\$ 312 million, complemented with R\$ 63 million for a 1 km elevated track (east connection) and R\$ 163 million for the *Cidade Tiradentes* extension (7).

Operação Via Livre

“Operação Via Livre” is low cost priority treatment, using designated lanes on the curbside with horizontal and vertical road markings and special traffic signals (4). A total of 30 corridors with a length of 204 km were planned to be transformed for this type of operation at a total cost of R\$83,5 million (USD 29,3 million, or USD 93K per km).

Terminals

Physical integration between the local and the structural services is achieved through terminals, which include enclosed paid areas allowing for seamless transfers between buses. The terminals provide other amenities (restrooms, stores) and distinctive image, as many of them feature high quality architecture. Most terminals are operated under concession contracts. The concessionaries receive a fixed amount per bus serving the terminal and are entitled to use billboards and dynamic advertisement and to operate

newsstands and coffee-shops. Concessionaries are required to keep the infrastructure in good condition and manage the terminal operations using advanced technologies.

The system plan includes 32 terminals; 14 of them implemented in 2002-2004 (4), at a total cost of R\$468 million (USD 164 million, or 5 million per terminal on average; many terminals were already in place requiring overhaul only).

Transfer Stations

Transfer stations are open facilities located at intersections between lines that allow connection among different system lines using the electronic farecards. Transfer stations are designed to make pedestrian connections as direct as possible to minimize passenger inconvenience. A total of 328 transfer stations were planned (4), with about 25 completed in the 2001-2004 period. Total cost for transfer stations was estimated in R\$ 97,5 million (USD 34,2 million, or USD 100 thousand per transfer station).

Bus stops

Bus stops have been improved to provide shelter and information for the passengers (maps and dynamic displays indicating next bus arrival time). There are 12 different types of sheltered bus stops with sizes between 4m of length and 1.8 m width to 38 m of length and 3.5 m width (4). Stations are open areas (no prepayment), since fare card validation is on-board. There are about 17,000 bus stops with an average spacing of 300m in the local network and 500 m in the structural network.

Vehicles

Several types of vehicles are used in the system, from 27m Bi-articulated buses to 5m minibuses. Fleet was calculated in 13,711 low-entry vehicles (7). Buses in the structural subsystem have doors on the left and the right hand sides to provide access from median and curbside stations bus stops. Bus fleet renovation has been extensive as concessionaires were required to maintain a fairly low average age of the fleet during the first years of operation. The cooperatives of self-employed van operators were required to acquire new minibuses to replace their obsolete vehicles.

Fare collection

The main feature of the Interligado System is the integrated electronic fare collection scheme through *Bilhete Único*, a contact less electronic smart card. Most of the fare validation is on board (only terminals feature prepayment). Each bus has a conductor controlling access through turnstiles located in the first third of the bus. Coin payment is possible, but free transfers are only allowed with the electronic card. The electronic cards are available in 700 "lottery selling" booths, in stands of SPTrans and in the system terminals. There are different types of cards: student, seniors (older than 65 years for men and 60 years for women), persons with physical deficiencies and employees of the system. Special cards allow for reduced fares and are only available at a few designated places.

The fare is time based allowing the passengers to use any service of the Interligado system with last validation within a two hour period. Abuse has been reported and the number of validations has been reduced to a maximum of 4. Flat fare was equivalent to 0.78 USD in 2004. Fare has increased since and has risen to 1.05 USD (November 2006) in an effort to reduce the system deficit.

The cost of the fare collection system was of R\$ 178,6 million (USD 62,7 million; 4). Most components (centralized system –hardware and software and farecards) were funded by the municipality (R\$ 103.6 million, equivalent to USD 36 million, 58%). Card readers and electronic turnstiles were purchased by the bus operators at a total cost of R\$ 75 million (USD 26 million, 42%).

Control

The system has centralized control and distributed control at regional sub-centers and the terminal stations (4). Centralized control is provided through an integrated control central (Central de Controle Integrado -CCI) operated by CET and SPTrans. The CCI is responsible for the general strategic control of all the sub-centrals.

The terminals are equipped with an operation central (COTs) which is in charge of the control of the arrivals and departures of the vehicles and detecting and solving operational problems. They also have Variable Message Panel (PMVs) which transmits public information messages. The system concessionaries have operation centrals (COCs) distributed in the 8 areas of the city. These centrals also have operational capacity to solve problems and give useful information to the users. The COCs are operated by a private company that got the concession to implement and operate the system and the terminals.

There are also regional control centers (COR) responsible for controlling the operations, dealing with emergencies within each region, supervising the operation and communicating with the drivers. Each vehicle is equipped with GPS and communication systems. In addition, there are cameras distributed along the corridors and in the terminals which are operated in coordination with the traffic lights (under CET). Regional control centers have group of supervisors working in the field. The control and monitoring system has a total estimated cost of R\$ 229.5 million (USD 80,5 million; 4). During the 2001-2004 administration a total of R\$92 million were invested in the control and monitoring system (40% of the estimated total).

ASSESSMENT

Planning

The project was a long lasting initiative of transport professionals in several positions in the local and state governments, the academia and professional associations (mainly the National Association of Public Transportation ANTP). The concept of segmentation of services (local lines and structural or trunk lines) and integrated ticketing is embedded in several transport plans, including PITU 2020. Studies for the implementation of an integrated ticketing system were completed in the city administration 1998-2001.

It was the administration of Marta Suplicy (2001-2004) which stated the priority for buses in the transportation strategy for the city, and completed the planning and implementation process in a coordinated effort of the Municipal Secretary of Transportation, SPTrans and CET.

About 21 different groups were formed to plan, develop and implement the several aspects of the initiative. About 350 professionals and seven consultant groups were listed as participants in the process (4). Planning efforts had to overcome several barriers (see Table 3).

Probably the most important barrier was the resistance of organized operators and self-employed operators. While the municipality wanted to include small operators in the new scheme for socio-political reasons; organized operators only wanted to reduce illegal operations.

Opposition from existing operators and the self-employed van operators was extensive; each group was defending their own interest. Operators and small owners boycotted the initial public information meetings in 2001 and 2002, organized citywide stand-offs, and even acted with violence against the institutions and each other. The municipal administration adopted a conciliatory and participatory approach ("*Conversando a gente se entende*", which means "people understand each other through dialogue", 4). Conditions to participate in the new concessions, fare collection, remuneration mechanisms, and the operation of local services by cooperatives were extensively discussed with industry and small owners' leaders. Many decisions were adopted to mitigate eventual conflicts with stakeholders.

In addition there were technical barriers for the definition of the new transport network and its operational features. Bus priority schemes would also be restricted to those not requiring road widening. The municipal technical team with the help of local consultants, developed the new network concepts and designed the new routes mainly by cutting off the local portion of the structural services and replacing it by local lines (feeder and local service) and eliminating redundant routes. The size of the network made this task very complex.

Table 3 Identification of Barriers and their Solutions or Mitigation Measures

Barrier	Barrier Details	Solution/Mitigation
Inter-agency coordination	Large scale reorganization of all transport services within São Paulo required the participation of several government agencies	Creation of a high level coordination group (Municipal Secretary of Transport, Director of SPTrans and Director of CET). Creation of several planning and implementation groups under a single coordination authority at the MST (Transport Planning Advisory). Designation of several professionals of the municipal agencies to the project with specific responsibilities in project planning and development.
Coordination with other levels of government	Metropolitan transportation under the authority of the State Government was developing a different agenda (rail based)	The Interligado Project was developed with a municipal scope only, but with the possibility of integration with metropolitan transportation. Political agreements were required between the State Government and the Municipality. Integration with regional transport was not achieved in the first stages of the project.
Regulatory Regime	Some systems components were not possible under existing regulations	Regulations were changed to allow several components of the Interligado System, such as the integrated fare collection system, the conditions for the transport concessions, integration of informal operators and other elements of the delegation scheme.
Opposition from transport industry leaders	Industry leaders were not interested in the modification of the existing regulatory regime and opposed project implementation	Dialogue and information. The municipality created the Municipal Council of Transport and Traffic, with a very broad representation, as well as a negotiation process with the bus operators' representative. The main interest of the organized operators was control of illegal operations by self-employed van operators (Peruveiros), and the economic guarantees for the new business scheme.
Opposition from van operators (Peruveiros)	Individual self-employed operators wanted to keep their informal operations without control of the authorities	Integration of small operators into the new scheme through cooperatives of self-employed van operators. Cooperatives were required to comply with minimum organizational characteristics, to bid for operation of local services, to introduce new fleet (microbuses and minibuses) and incorporate electronic fare collection in their systems.
Large scale reorganization	Route reorganization of public transport services in a metropolitan area is a complex technical problem (supply-demand balance)	Participation of a competent team of professionals both from the municipal agencies and consultancies. The route reorganization approach was fairly straightforward: segmentation of services (local, structural) and elimination of redundancies. The new network is rather complex
Limited funding availability	The municipality had limited resources for infrastructure	Use of existing right of ways, rather than costly expansions, as well as low cost solutions for bus stops, integration points and terminals; credit from the Brazilian Development Bank BNDES was obtained for investments in the first two phases of the Interligado System
Neighborhoods opposed busways	Trunk ways had a bad image due to poor urban design and negative impacts to the surrounding communities of previous projects	Information and discussion with the community of the new characteristics of the priority schemes, which were designed to be less intrusive than the trunk ways implemented in the past (e.g. Nove de Julho-Santo Amaro corridor)

Decision process

The project was part of the municipal agenda of Major Marta Suplicy (2001-2004). Transformation of bus service delivery was one of the strategic actions of her social agenda. The Major took advantage of the long lasting ideas of priority for buses and integration through technology to propose a fast change in bus service delivery. The technical group in the Municipal Secretary of Transportation, SPTrans and CET, had already worked the general concepts of an integrated system and studies for an electronic fare collection system were completed in previous administrations. Decisions regarding key aspects are presented in the following subsections.

Bus Operators

The decision made was to choose the operators through a limited bidding process, with priorities to existing operators and inclusion of a new category: cooperatives of self-employed van operators. Separated bidding processes were organized for the structural components (8 area concessions connecting city areas with the city center) and for local services (8 permits for local/feeder area services). Preparation of the bidding conditions was a difficult process, which was discussed with the interested parties. Emergency concession contracts were signed in January 2002 for a six month period, and extended twice (until July 2003) to give time to the project preparation and implementation of infrastructure and technology components.

The main activities assigned to the bus concessionaries are:

- Operate the bus fleet with electronic reader and turnstile
- Acquire and maintain the bus fleet with a maximum age of 10 years and an average age of 5 years (to be gradually complied in year 2008). New vehicles shall comply with the technical specifications defined by the authorities.
- Improve and operate the terminal facilities (sub contracted with terminal concessionaries)
- Provide buses with accessibility to wheelchairs (at least one per line served), and vans for free transportation of people with special needs (*Atende, 4*).
- Maintain valid emissions certificates for their vehicles

Revenue was defined in a formula which intends to provide an 18% rate of return. The formula includes several components and a readjustment mechanism to include variations in cost components and inflation.

The cooperatives of self-employed van operators were required to legalize the vehicle and driver permits, to be incorporated (register by-laws) and to gradually replace the informal vans by micro and minibuses. The main requirements of the permissionaries are to:

- Operate local services with equipped buses (electronic reader and turnstiles)
- Propose local routes for approval of the authorities, and inform users of the available services and their changes
- Provide vehicles with wheelchair accessibility
- Maintain valid emissions certificates for their vehicles

The local services are remunerated with the income from user fares with adjustments for vehicle size and loss revenue from discounted trips (*gratuidades*).

Fare Collection

Fare collection was considered the most important component of the new integrated scheme. The components of the fare collection system are:

- On board systems (card reader and electronic turnstile, processing unit and memory), provided by the bus operator.
- Garage and terminals information systems. Includes reading, processing and communication devices. Collect the information from the processing units on the buses and send the information to the central processing unit. These systems are provided by the bus operators.
- Credit distribution and commercialization system. It is a network of SPTrans booths and contracted stores (e.g. lottery booths), that sells transport credits in the electronic farecards. The electronic farecards were initially acquired by SPTrans and distributed through this network.
- Central system for credit emission. Includes central processing equipment and communication devices. It integrates all the information and conciliation. This system is contracted by SPTrans with a technology provider.

Implementation approach

The Interligado system was implemented through several gradual steps (4). Initial steps included the introduction of priority lanes (curbside) through several corridors of the city (*Operación Via Livre*). Buses started to use the new system image in January 2003. New terminals and corridors were then completed (*Passa-Rápido*) and structural and local services created.

System integration for bus services within the Municipality of São Paulo was completed in May 2004, when all buses, minibuses and vans authorized to operate the municipal services were equipped with electronic fare collection on board, and when the credit distribution network was operational (4). Integrated operations started all together; nevertheless, infrastructure and operational improvements, as well as fleet renovation, continued over the next three years. Integration with several regional bus services operated by the state agency EMTU started in 2004, and agreements with Metro and Regional Trains were achieved in 2006. Fare integration with the rest of the state fleet and the multiple municipal agencies operating bus services in the Metropolitan Area will take several years due to the multiple authorities involved.

Implementation

The integrated fare collection system *Bilhete Único* started full scale operations in May 2004 (4). Operation on several terminals and *Passa-Rápido* corridors was already in place, while many other facilities were under construction or planning. The main problems observed during the implementation were:

- Distribution of credits was difficult
- Many facilities were inadequate – small bus stops and transfer stations cause bus queuing and delays

- *Via Livre* corridors (curbside) were not respected by the general traffic (delivery trucks, taxi cabs)
- Incomplete user information on routes and frequencies (maps were difficult to understand).

Implementation problems are discussed in the following subsections:

Design Issues

The design of the priority schemes was aimed to make use of available right of way and to minimize the cost of interventions. Busways are open: buses can feed in and out of the trunk way. Regional buses with left doors are allowed to use the corridors. As a result, reliability of the operation is variable and limited capacity of the bus stops often leads to spillovers and reduced commercial speeds.

Busways are only segregated from the general traffic through road markings. Median side lanes work much better than curbside lanes, but still suffer from invasions from general traffic, reducing the reliability of the operations. Operations are enforced using cameras, but they do not seem enough deterrent of invasion, especially under severe congestion conditions.

Infrastructure

Even though infrastructure for Interligado was rather simple (bus stops, integration stations, terminals), the completion suffered the chronic delays of public works projects (expropriations, contracting, implementation, permits by different authorities). In addition, construction of busways faced opposition from surrounding communities, largely inspired by the negative urban impacts of the previous busways in São Paulo. In particular the *Rebuças Passa-Rápido* was stopped after the community filed a law suit against it. Additional public hearings were held to incorporate some of the community concerns into the corridor design (4).

A similar case happened in *Avenida Ibirapuera*, when residents accused the City Hall of an environmental crime by cutting 35 trees and removing 97 (10). The City Hall planted 368 new trees as part of the environmental compensation plan of the corridor.

Additionally, the infrastructure allocated to support integration and bus operations was insufficient. This was especially critical in transfer points, where the lack of enclosed facilities caused operational problems (very long dwell times resulting from entrance and validation through a single door). Lack of segregated lanes or the designation of curbside lanes (often invaded) also generated problems to bus operations.

Operations

The operators, especially the cooperatives of self-employed van operators indicated that the compliance periods were too short (11), especially considering the difficulties in obtaining loans to buy the new vehicles. Variability of the rates and the bureaucracy involved in processing loans made the process difficult.

Support Systems

Systems integration of the fare collection system for the level of transactions in São Paulo (around 16 Million per day, including sales, recharge, validation, integration, and conciliation) was a mayor enterprise. An adaptation period was required for seamless operations. One aspect that helped in the process was the extensive training in the fare collection technology to those in charged of operating it (conductors, supervisors, authorities). The system was flexible, as manual payments are allowed on board (paying the conductor directly); many users without electronic farecards can still use the system, although they are not able to make free transfers.

The advanced monitoring and control systems are mainly used to gather information to feed the variable message displays, but not extensively used to improve operations on-line.

User Education

The municipal administration has educated users on the new system characteristics, especially on the use of the electronic fare collection system. Despite the large education effort, many users were confused when changes were introduced.

OPERATIONS

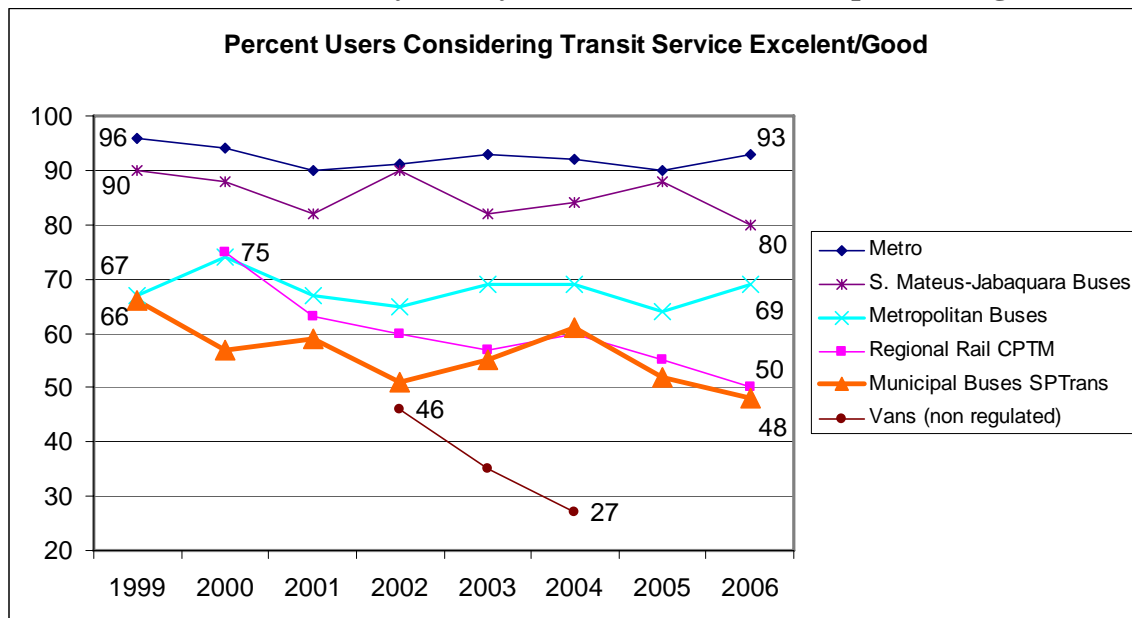
The system was introduced gradually, with only mayor changes occurring in May 2004 (introduction of *Bilhete Unico* and integrated operations). According to a report by the Municipality of São Paulo, only 39% of the total investment (R\$ 930 million, equivalent to USD 326 million) was in place by the end of 2004 (7). Main components to be completed were 23 *Passa-Rápido* corridors (226 km) and 18 terminals with the support systems (monitoring, control and user information systems).

The annual quality survey (12), indicated in 2004 that the implementation of *Passa-Rápido Perituba-Lapa-Centro* was considered as excellent or good by 85% of the users. *Bilhete Unico* was also relatively well received by the users: in 2004 78% of the users said that the principal advantage of the *Bilhete Unico* was the ability to take several buses while paying one fare; and 48% said that the electronic card allow them to pass quicker through the turnstiles.

Nevertheless, the overall image of municipal buses (under SPTrans) declined over the last 7 years, despite the introduction of the Interligado System. Figure 1 shows the results of the ANTP's transit quality survey for 1999-2006. Only 48% of the users considered municipal buses good or excellent by 2006 (12).

In the 2006 ANTP survey (12), the main concerns about the operation of municipal buses were the high level of emissions (99%), congestion (88%), long waiting times (82%) and long travel times (80%).

Figure 1
ANTP Transit Quality Survey for the São Paulo Metropolitan Region



Source: (12)

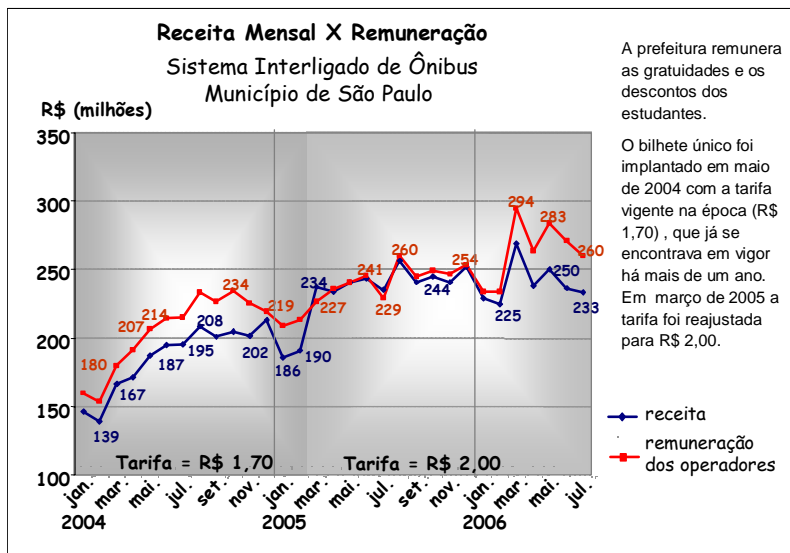
In addition to the low user ratings the municipal system faced financial problems due to the growing number of “free” or discounted services (*gratuidades*). According to a commentator (13) before the implementation of the Bilhete Unico the municipal government paid the operators R\$80 thousand per month in “*gratuidades*”. By the end of 2004 were R\$50 million per month. The geometric progression of the “*gratuidades*” forced the City Hall to reduce to 4 boardings per 2 hour period.

System revenues and costs have been unbalanced due to the political definition of user fares. Figure 2 shows that system revenues (“*receita*”) have been below system costs (“*remuneração dos operadores*”) in years 2004 and 2006 (electoral years), while there has been equilibrium in 2005 (when the user fare rose to R\$ 2.00). The user fare was again increased in November 2006 (9).

According to newspaper comments the municipal administration under Mayor Jose Serra (2005-2009) was ineffective in making the operators rationalize the itineraries to upgrade the service quality (12). Since 2004 the government has announced that at least 80% of the 1.3 thousand bus lines present some sort of irregularity. Factors like overlapped lines, competition between buses, vans and minibuses, fully loaded vehicles and convoys circulating completely empty, are raising the system costs. The Transport Secretary has admitted that the problem is in the fleet’s distribution (no match between supply and demand) and has taken actions to improve the situation.

On the other hand, operators, especially the cooperatives of self-employed van operators, indicate that they receive too many contractual fines without a proper identification of the infractions from the SPTrans (11).

Figure 2
System Revenues and Payments to the Operators January 2004 – July 2006



Source: (9)

RECOMMENDED IMPROVEMENTS

The main improvement is the completion and enhancement of several *Passa-Rápido* corridors, terminals, transfer stations and monitoring and control devices. Contract compliance should be looked closely. Additional improvements (medium and long term):

- Technical definition of fares to avoid financial stress
- Evaluation and development of high capacity BRT applications to reduce dwell time and improve commercial speeds on main corridors: strong longitudinal segregation of the bus lanes through the construction of barriers, banning taxi cabs and enforcing violators; increased prepayment (enclosed stations, and paid areas); and continuous adjustment of services taking advantage of the intrinsic flexibility of buses, for example through the introduction of express or accelerated services and short loops for heavy loaded sections
- Inclusion of emergency response systems. Current oversight scheme seems to be restrictive, and does not provide enough flexibility to perform real time operational actions in case of incidents (such as public protests, heavy rain, accidents, etc.)
- Document and share the experiences gathered during planning and implementation, and continuously measure performance and user satisfaction.

LESSONS LEARNED

The São Paulo experience can be considered a good practice in implementation of transport reform in developing cities: transit services became more attractive as user cost and travel time was reduced; fleet was renewed and several operational inefficiencies trimmed down. Integration efforts continue, including coordination with the Metro and

regional rail and bus services. Key elements of success were political commitment, coordinated effort of several agencies, technical preparation, and inclusion of existing companies as well as informal operators. Several aspects need further attention to improve service quality and user perception.

The experience can be favorably compared with other efforts in Latin America, such as Santiago (14) and Bogotá (15). In contrast with Santiago, service changes were introduced gradually (as corridors and terminals became available) and existing operators (formal and informal) were included. Integration with Metro and regional rail also occurred later in the process. Nevertheless, Transantiago was able to capture the benefits of a more open competitive tendering for bus operations and introduce stronger controls on the private operators.

Compared to Bogotá, São Paulo achieved a citywide integration; while TransMilenio only covers a fraction of the public transport demand and continues its operation along with less formal and more inefficient operators (16). On the other hand, TransMilenio components provide higher capacity and performance than the softer BRT elements in the *Passa-Rapido* and *Via Livre* corridors.

FURTHER STUDIES

Several aspects of this case study deserve further attention. For instance, the process of formalization of illegal van operators was remarkable and deserves better review of the process and impacts. Additionally, it will be important to study in deeper detail the user education mechanisms and processes, which are also critical in successful integration and quality of service perception. Finally, it will be interesting to monitor the evolution of the reform process compared with other experiences.

ACKNOWLEDGEMENTS

Initial work was produced with the financial assistance of a grant from TRISP, a partnership between the UK Department for International Development and the World Bank, for learning and sharing of knowledge in the fields of transport and rural infrastructure services. Special thanks to Pierre Graftieux for guiding the work and to Paulo Custodio and three anonymous reviewers for their comments. The views expressed in this report are those of the author and do not necessarily reflect the views of the World Bank, EMBARQ or the World Resources Institute.

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