

São Paulo: a challenge for the bus & intermediate systems

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Faced with incessant growth the São Paulo authorities are attempting to solve the traffic congestion, pollution and travel problems in this immense urban area. With projects held up for a long time due to inadequate financial resources forthcoming from the state and the city, they are now looking towards private sector initiatives in order to develop their urban transport systems.

A megalopolis of nearly 18 million inhabitants

Founded in 1560, Vila de São Paulo de Piratininga underwent sustained rapid growth with the coffee boom the end of the 19th century. The first mayor of São Paulo, Antonio da Silva Prado, elected in 1889 at the advent of the Republic of Brazil was a dynamic influence on the city and completed major town planning works such as tram lines. The first town planning plan was drawn up in 1911 and in 1927 the Light Plan established a fast traffic flow system which created priority lanes for trams. The structure of the metropolis thus remained unchanged until today although the city grew on the site of the plateau and hills between the Tiete river to the north and its tributaries, the Pinheiros and the Tamanduatei, to the west and east respectively. The city of São Paulo, whose population had been a mere 250 000 inhabitants in 1900, now has 9.5 million inhabitants in an area of 1 530 km². Population density in the central zones are over 155 inhab/ha and up to 300 inhab/ha around the historic centre whose narrow, shopping streets in the vicinity of Sé cathedral have remained unchanged. To the west of the historic centre is the new centre sprawling over a much greater area featuring wide avenues and buildings with bold architecture. The Avenida Paulista with its residential and office block skyscrapers and shopping malls makes up São Paulo's 3rd centre. Densities in the rest of the Paulista urban area typically features are approximately 100 inhab/ha since it comprises primarily houses or small buildings. Most of the favelas are implanted on the flood plains along valley floors.

Breakdown by means of transport within the RMSP

| Means of transport used | journeys/day x 10 ⁶ of motorised journey | % of motorised total | % of general total |
|---------------------------------|---|----------------------|--------------------|
| SP city centre bus | 4.5 | 22.2 | 14.5 |
| Bus in the other cities | 3.265 | 16.2 | 10.6 |
| Total: RMSP buses | 7.765 | 38.4 | 25.1 |
| Underground | 1.688 | 8.3 | 5.5 |
| Suburban trains | 0.654 | 3.2 | 2.1 |
| Total: mass transport | 2.342 | 11.5 | 7.6 |
| Total: urban transport | 10.107 | 49.9 | |
| Car (& taxi) | 9.578 | 47.2 | 31.0 |
| Other (& minibus) | 0.582 | 2.9 | 1.9 |
| Total: car | 10.16 | 50.1 | 32.9 |
| Total: Motorised Transport (MT) | 20.267 | 100 | |
| On foot | 10.615 | | 34.4 |
| General total: GT | 30.882 | | 100 |

Source: O/D 1997, Revista dos Transportes Públicos - ANTP- Ano 21 - 1999 - Quarter one

The population growth rate has slowed down. Previously at an annual average of 10.92% between 1970 and 1980, then 4.46% per year between 1980 and 1991, it is now only 1.9% today. The city of São Paulo enjoys a solid industrial base and is becoming a major service business centre featuring a high concentration of businesses, shops and services (up to 430 jobs/ha in the traditional centre on the Avenida Paulista), the whole making up the largest single contribution to Brazil's gross national product (16%). The São Paulo metropolitan area (R.M.S.P.) covers the city of São Paulo and 38 other municipalities spread over an area of 8 051 km². It is home to 18 million inhabitants. It stretches beyond the city centre in a star formation in three main directions:

- south-eastwards along the railway line and the road to Santos (Atlantic port) home to the highest demographic (approximately 2 million inhabitants) and industrial concentration known as the ABCDM area covering five local municipalities;
- eastwards, along the railway lines to Rio and along the Dutra motorway (800 000 inhabitants);
- westwards, along the Tiete river and the railway line (over one million inhabitants).

The R.M.S.P. provides over 7 million jobs (70/30 split between the service and secondary sectors) but has one million unemployed. Its business activities are located around several key centres including the city of São Paulo and the extension zones situated to the south-west and north-east.

Public transport systems dominated by the bus

The public transport system in the São Paulo area comprises the following:

- a metropolitan system: suburban trains, the underground and metropolitan buses. This system is governed by the State of São Paulo via the intermediary of its metropolitan transport secretariat (S.T.M.);

- a municipal system: the São Paulo bus system, managed by the municipality via the intermediary of its municipal transport secretariat (S.M.T.);

Together these systems account for nearly half (49.9%) of the 20 267 000 motorised journeys (1997) made within the metropolitan area on a daily basis (journeys between the far-flung dormitory towns and São Paulo as well as journeys generated by the different centres). The other half of all journeys (50.1%) are made using private vehicles on its congested highway system (the town of São Paulo has 0.5 vehicle per inhabitant). Buses account for most of the journeys made on the public transport system: 76.8% of such journeys are actually serviced by buses, 32.3% on inter-urban buses and 44.5% on urban buses. The tram has not been in operation since 1968 and it is left to the bus to make up for low coverage of the underground (50 km) and metropolitan train (270 km) systems. In the opinion of the users buses make up for the inadequate underground system and is more accessible.

Bus & trolley bus line operation

Operators are private but have a public service mission. Lines are allocated subject to call for tender, under the respective control of the following management authorities: São Paulo Transportes (SPTTrans) - municipal lines and Empresa Metropolitana de Transportes Urbanos (EMTU) - metropolitan lines.

Vehicle fleet

Over 15 000 buses or trolley buses travel around the São Paulo metropolitan area on a daily basis transporting approximately 8 million users:

- 3 634 vehicles including 124 trolley buses on the inter-municipal system;

(1) -On March 27th 1968, a final cortege of 12 camaroes trams made their last trip to Santo Amaro marking the end of 96 years of tram service in the city (The tramways of Brazil, by Allen Morrisson, Bonde Press, NY 1989).

- 11 612 vehicles including 552 trolley buses on the São Paulo municipal system.

The first trolley buses were put into service fifty years ago but projects were reactivated by the oil crisis in 1973 and pollution problems.

Several dozens of kilometres of lines have been commissioned since 1977 and trolley buses currently circulate on:

- 4 lines servicing the ABCD commune grouping to the south-east of São Paulo;
- 19 lines (265 km) in the city of São Paulo, including three ring roads servicing the terminals around the historic centre (Princesa Isabel, Bandeira and Parque Dom Pedro II terminals).

The future of the trolley bus in São Paulo is now secure thanks to awareness vis-à-vis the pollution problems relating to traffic congestion.

A certain number of these vehicles, buses or trolley buses, travel on exclusive busways. The vehicles involved are large capacity fitted with doors on both sides to allow passengers on and off at the raised platforms. Vehicles are thus able to travel either on exclusive busways or on the normal highway.

Exclusive busways or "corridors"

There are approximately one hundred kilometres of busways along the avenues but the lanes require constant monitoring due to the fact that they are not separated from the rest of the traffic.

It is for this reason that, at the beginning of the 80s, the first exclusive busways or "corridors" connected to connection terminals made their appearance.

The Paes de Barros exclusive busway, the first of its kind, is operated using trolley buses and stops operates to the left of the traffic flow direction. Vehicles travel at an average speed of 18 km/hr.

The Santo Amaro / 9 de Julho exclusive busway and the Ceiso Garcia exclusive busway (8.6 km, 500 buses/hr/dir. on a double lane and a progressive signal after 1987) were operated on a convoy system until the beginning of the 90s. Convoy operation² enabled 6 buses following a few metres behind each other to cross the lights at the same time, thereby cutting down on journey times. It was not possible to continue with the scheme, however, because of inconvenience by pirate minibuses on the exclusive busways.

(2) - The technique known as COMONOR (COMbois de Ônibus Ordenados, convoy-aligned buses) in application on exclusive busway lines at Porto Alegre. This form of operating requires buses to be aligned on entering the exclusive busway, by line frequency, and stops to be organised by user destination with each bus drawing up to the right of its stop. The bus' position in the moving convoy identical to the one at the station. Organisation of this type together with the ability of overtaking on the right at stops enables line capacity and commercial speed to be increased.

Main exclusive busways in the R.M.S.P.

| Exclusive busways | Year | Length (km) | Terminal | Fleet* | Bus hr/dir.*** | Overtaking lane | Daily passenger traffic |
|------------------------|---------|-------------|----------|--------|----------------|-----------------|-------------------------|
| Paes de Barros | 1980 | 3.4 | 1 | 61 | 57 | No | 64 000 |
| Santo Amaro/9 de Julho | 1987 | 14.6 | 2 | 1392 | 270 | Yes | 304 000 |
| Vila Nova Cachoeirinha | 1991-96 | 25 | 1 | 226 | 177 | No | 199 000 |
| São Mateus-Jabaquara** | 1988 | 32.6 | 9 | 196 | 63 | Yes | 250 000 |

Source : Revista dos Transportes Públicos - ANTP [Rebelo, 1994], [Gimenez, 1998].

* Total number of vehicles on lines using the exclusive busway.

**The first 3 exclusive sites are municipal (SPTrans), the last one is metropolitan (EMTU).

*** On the heaviest section.

São Paulo public transport systems

Underground system

supply

- management authority: Companhia do Metropolitano de São Paulo - Metro - SP
- system: 3 lines over 50 km and 49 stations, line 1 north-south from Tucuruvi to Jabaquara, line 2 north-west - south, line 3 east-west from Itaquera to Barra Funda.
- connecting stations: with the train 7, with bus terminals 16.
- fleet: 51 trains on line 1 and 47 trains on line 3, i.e. 588 carriages in 1997.
- rush hour intervals between trains: 117 secs (line 1), 183 secs (line 2), 111 secs (line 3).
- commercial speed on lines 1, 2 and 3 is 28.30 and 35.7 km/h respectively.
- operation is performed using automatic protection systems (ATP), driving systems (ATO) and train monitoring (ATS) via a PCC.
- service amplitude: from 5am to 12pm every day
- maximum capacity on lines 1 and 3: 60 000 pas/hr/dir.

demand

- traffic: 1 650 000 travellers per average day in 1998, 674 million travellers in 1998 (701 million in 1996).

Suburban trains

supply

- management authority: Companhia Paulista de Trens Metropolitanos - CPTM
- system: 6 lines (lines A, B, C, D, E and F), linear track of 270 kms and 91 stations.
- connecting stations: with the underground: 7 with bus terminals: 18.
- fleet: 266 trains with a total of 919 carriages in 1997.
- rush hour intervals: 12 mins on lines A-D-E-F; 8 mins on line B, 18 mins on line C.
- commercial speed: 42 km/hr on lines A/D and E/F, 38 km/hr on line B, 44 km/hr on line C.
- operation is performed using a centralised traffic control system (CTCS), automatic train control system (ATC) and a data transmission system (DTS).

- service amplitude: from 4am to 12 pm every day
- maximum capacity on line B: 20 000 pass/hr/dir. demand
- traffic: 800 000 travellers per average day (272 million passengers in 1997).

Inter-municipal bus & trolley bus system

supply

- management authority: Empresa Metropolitana de Transportes Urbanos - EMTU.
- system: 54 private operators, 485 regular lines over 26 000 km in the RMSR.
- 87 lines feature connections to the underground system.
- fleet: 3634 vehicles in 1997 including 3424 conventional 2-door buses, 124 trolley buses.

demand

- traffic: 462 million passengers in 1997 and 1.5 million per day in the RMSR, 69 million of which move in the ABD corridor or 250 000 passengers per day.

Municipal bus & trolley bus system

offer

- management authority: São Paulo Transporte SA¹ - SPTrans
- system: 50 private operators
- 829 lines, 21 395 km, 33 municipal terminals.
- fleet: 11 612 vehicles in 1998 including 552 trolley buses and 145 gas-fuelled buses.

demand

- traffic: 1.610 billion passengers in 1997 or 5.3 million users per day
- 33 000 taxis (650 000 users/day), 2 700 registered minibuses, 4 000 school transport vans.
- 7 000 illegal vans (estimate)

(1) - The Companhia Municipal de Transporte Coletivos (CMTC) founded in 1947 was superseded by SPTrans in 1995.

The Vila Nova Cachoeirinho exclusive busway commissioned in 1991 and extended in 1996, operates to the left of the general traffic flow, along the central reservation, with double flow sections at stations allowing direct buses to overtake. The stations, designed on islands feature raised platforms and are long enough to take two articulated buses fitted with widened doors on the left to reduce boarding /disembarking times.

The exclusive busway has a capacity of up to 20 000 p/hr/dir.³, with 120 buses per hour in each direction. The site has been such a success that it has become the benchmark for future exclusive busway projects.

The last exclusive busway was commissioned in 1988 between São Mateus and Jabaquara, the southern terminal on underground line 1 to service the ABCD zone to the south-east of São Paulo. This average capacity system built by the underground company is used by 4 lines and 189 vehicles including 46 "padron" trolley buses (105 passengers) and 78 new articulated trolley buses (170 passengers). This exclusive site, which will be entirely operated with trolley buses within 5 year's time is designed to service daily demand of 250 000 travellers.

These "corridors" are connected to terminals which provide connections between lines running along the exclusive busway and lines bringing commuters in from areas around the latter. A single unit is used to control all lines in the zone and ensure regular operation.

Alternative transport: minibuses & vans

Heavy means of transport and traditional buses are not capable of satisfying all travel requirements, in particular diffused demand which can only be met by alternative means of transport which are lighter and more flexible in terms of operation.

In São Paulo, therefore, there has been a trend towards minibuses whose advantages in terms of convenience, speed, flexibility and short waiting times have filled the gaps left by the regular systems. The impact of van services on conventional transport is significant with 2 700 vehicles registered for regular operation. Given the number of major traffic routes in operation, however, estimates set the number of alternative transport vehicles at 7 000, even 15 000 depending on the source. Such alternative transport accounts for the 10% drop in bus traffic observed in 1996. SPTrans issues transport permits to 9 to 16-seater vehicles for specific services or long distance services unsuitable for conventional transport. SPTrans controls and manages the system by analysing the services offered and using an information system.

Scheduled developments

Various studies have shown that users and the population as a whole appreciate the services provided by the underground and the metropolitan buses on exclusive busways such as São Mateus-Jabaquara. However, in spite of their high traffic capacity (up to 20 000 p/hr/dir. with one bus every 30 seconds), exclusive busways often function to

capacity and are only capable of covering distances of one hundred kilometres.

Key bus user demands include higher frequency and amplitude, the creation of feeder lines to reduce journey times, the creation of new urban terminals to reduce journey times, the construction of exclusive busways, connections with the underground, greater numbers of differentiated services such as minibuses and express lines, cleaner and more comfortable vehicles (more seats).

To resolve travel problems, the authorities have therefore decided to invest in exclusive busways, in the intermediate system in particular and also extend the underground at the same time.

The intermediate system: an average-capacity exclusive busway system

In order to improve exclusive busway productivity, SPTrans which manages the São Paulo bus system, has opted for an integral exclusive busway system which is totally independent of the main traffic flow. The system involved is average capacity (13 000 to 35 000 p/hr/dir.) and can be built rapidly at low cost, on viaducts or at ground level where possible reusing existing corridors.

The vehicle scheduled will be a light, run on tyres, bi-articulated, fitted with two electric motors and be laterally guided. The necessary capacities will be achieved at a commercial speed of 30km/hr and vehicles can be coupled or operated in a convoy. The system will cost 15 M US\$/km (including viaducts and equipment fleet/installed base).

SPTrans has been developing its prototype light tyre-fitted⁴ vehicle on a special test site. It has designed line itineraries in such a way as to modify the radio-concentric structure typical of the existing bus system. The chosen project features a loop with a 10km radius which goes around the historic centre of São Paulo, 6 groups of lines⁵ totalling 125 km and 20 terminals. The intermediate system is scheduled for operation with 440 vehicles and is designed to transport over 1.6 million passengers per day.

Works on the first line (Sacomã-terminal Parque Dom Pedro II) started in 1998.

Bus corridor projects

SPTrans has also implemented a three-phase plan to extend the exclusive busways, known as P.I.C.T.I. (Programme for implanting corridors and integration terminals) designed to implement a fully-fledged, integrated city bus system to complement the intermediate system. The first two phases of the P.I.C.T.I. involving the construction of 6 corridors (nearly 100 kms) and 9 terminals as well as the modification of the Santo Amaro corridor (20 kms) are now complete. The 3rd phase, estimated at 450 M US \$ is a scheme involving the construction of 11 corridors (145 kms), 13 terminals and the modification of 7 existing terminals. A private sector works concession scheme has been launched in order to reduce the public investment involved. Similarly, on behalf of the State of São Paulo, the EMTU has prepared a concession comprising 6 corridors (127 km)

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and 6 terminals in accordance with the PITU (Integrated Urban Transport Programme); a scheme also designed to extend the subway system and suburban train lines. Additionally, a concession for a 2nd phase comprising 9 corridors terminating at underground or metropolitan stations and 21 terminals, is currently in the preparation stage.

In order to increase productivity in terms of bus operation and accelerate the implementation of the corridor development programme, the São Paulo authorities are turning to the private sector to provide construction and maintenance for the public integrated road infrastructure as well as services over an eight-year period. However, since the private sector is primarily interested in system operation it is reluctant to invest in infrastructure projects, a factor which risks delaying the commissioning of both the different corridor projects and the intermediate system.

(3) - p/hr/dir: passengers per hour per direction

(4) - Known as VLP - Veículo Leve sobre Pneus - or "Fura Fila" "vehicle which penetrates traffic congestion".

(5) - Sacomã - Parque D. Pedro II, São Mateus - Parque D. Pedro II, Pinheiros - Brooklin - Sacomã, Cidade Dutra - Terminal Bandeira, Radial Leste - Parque Novo Mundo, Santo Amaro - Terminal Bandeira.