LATIN AMERICAN EXPERIENCE WITH BUS RAPID TRANSIT

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Abstract

Since the 1970s, transport planners have commented on the busway operations that had been pioneered in several Brazilian cities – especially Curitiba which was then a relatively small city. Although these initial experiences were highly successful, few other cities were emulating that type of urban transit approach which was often considered a special solution good for Curitiba, but not replicable elsewhere, especially outside Brazil. Then, twenty years later, Quito and Bogotá decided to implement busway-based mass transit, copying several of the features of Curitiba and adapting them to their own circumstances. The success was stunning and immediate, and many delegations from around the world have been visiting those three cities to learn from their experience. Bus Rapid Transit (BRT, a fairly recent term) is now being planned in many cities on all continents.

This paper gives a descriptive overview of the BRT and major busway systems currently functioning in 10 Latin American cities, and 11 additional ones where new BRTs will start operations in the next two years. Drawing on the data collected for each system, the paper then summarizes the physical, operational and institutional dimensions of the Latin American experience and comments on their productivity, financial characteristics and public acceptance. It concludes that BRTs can provide high-performance rapid transit services at very low cost and should thus play a major role in future public transport policy – not only in Latin America but also in cities throughout the World, where budget constraints make it impossible to quickly build large-scale freeway or rail systems.

BRT Systems Currently Operating in Latin America

BRT has many different dimensions – physical, operational, institutional, financial, social, environmental, developmental, and political – and each city needs to find its own approach when implementing this concept. This calls for new ideas and experiments, and that is exactly what has been happening in Latin America which in the last decade has become a fascinating urban transport laboratory. As of April 2005, ten cities are operating some type of BRT and/or busway system – seven of them in Brazil, and one each in Ecuador, Colombia and Mexico, as shown in Table 1:

Table 1: Existing BRT and Busway Systems in Latin America

City	Metropolitan Population (M)	Start of Operation	Number of Busways	Length of Busways (km)
Curitiba	3.1	1974	6	65
Goiânia	1.9	1976	2	35
Porto Alegre[1]	4.0	1977	8	27
São Paulo[1]	20.0	1979	8	142
Belo Horizonte[1]	5.4	1981	1	6
Recife[1]	3.7	1982	3	16
Campinas[1]	2.6	1985	1	5
Quito	1.6	1995	3	33
Bogotá	8.1	2000	5	53
León	1.4	2003	3	26

[1] Refers to segregated-busway systems which do not include many other aspects of BRT operation
SOURCES: see Annex Tables

Curitiba, Brazil: The standards of busways and bus operations passed through many changes and evolved from a "simple" bus line on the first busway in 1974 to a sophisticated BRT system which is now fully integrated with all bus services in the metropolitan area, providing transport anywhere for a single flat fare equivalent to about 74 US Cents. The busway system was conceived in the early 1970s as an urban (rather than transport) planning initiative, aiming to concentrate population and economic growth along "structural axes" and thus to contain urban sprawl. The coagulation of development along five radial busway corridors did in fact occur (Curitiba grew from less than a million to 3 million inhabitants during that period), resulting in a unique urban structure of a star-like high-density development which proves to be highly efficient transport-wise. It is reported that, while Curitiba has one of the highest car ownership rates in Brazil, it consumes less gasoline per capita than other Brazilian cities, in part because more people walk and/or use public transport.

The busways are located in the center of the street and have one lane in each direction, without passing lanes at stops – which limits their line-haul capacity. As passenger demand was rising, several new features were invented to accommodate the ever increasing passenger volumes. Among these were (a) the introduction of express bus services, running on parallel (originally uncongested) roads and connecting with the busway every 3-4 km, (b) the now famous tube stations along the busway which involve high-level boarding and fare prepayment, and (c) the use of specially designed bi-articulated buses capable of carrying 260 passengers each. These 25-meter long buses proved to be very successful, both in terms of economy and passenger acceptance; all trunk-line services are now provided by nearly 250 of these bi-articulated buses.

The Curitiba system continues to be improved, and a new 22-km long busway is under construction, with financial support from the Inter-American Development Bank.

Goiânia, Brazil: The first busway originally built in 1976 was remodeled in 1999 with central high-level platforms, and using fare prepayment and 89 articulated buses with doors on the left side. At the terminals, free transfers were provided with integrated feeder buses. A second busway was then built, surprisingly with low-level platforms to the right of the buses and no fare integration with feeder buses. The lack of a coherent planning and management strategy has been noted in one available source, as well as the relatively unattractive design features. Nevertheless, this is one of the earliest BRT systems anywhere, and at least on the original line appears to operate quite successfully.

Porto Alegre, Brazil: Started in 1977, the bus mass transit system has been gradually expanded and now covers eight bus corridors, with a total length of 50 km of which 54 percent are segregated from general traffic. The busways have one lane in each direction, with low-level platforms and no passing lanes at stations.

Nevertheless, extremely high peak passenger volumes have been reported (over 26,000 passengers per hour per direction in 1991[1]; a more recent source mentions only 14,300 pphpd, reflecting the diversion of passenger demand to a new parallel corridor[2]). These volumes were produced thanks to the bus ordering model, evolved from the convoy (platoon) system previously employed in São Paulo. Under this technique, buses are assembled into convoys at the start of the busway, in a sequence corresponding to the route and standing order at the individual bus stops along the busway. The objective is to maximize throughput by having groups of buses start and stop almost simultaneously, similar to the cars of a train; convoys of up to six buses operate on the Avenida Assis Brasil and Avenida Farrapos busways.

While Porto Alegre was one of the pioneers of urban bus reform in the late 1970s, public transport grew haphazardly thereafter, and ever more buses terminated in the city center, which gave it the aura of an enormous bus depot and led to a general deterioration and loss in property values. The recently elected city administration intends to restructure the bus system and upgrade the busways, applying some on the principles of Bogotá's TransMilenio system (see below), such as regulatory reform, trunk-and-feeder operation, high-level platforms, passing lanes at stations, express services, and fare integration.

São Paulo, Brazil: The municipality of São Paulo, which accounts for about half of the metropolitan population, was another of the early pioneers of busway development. Perhaps best known was the 15-km long Nove de Julio busway, along a corridor not served by the metro. It had one lane per direction but included extra passing lanes at most stations; similar to Porto Alegre, buses were arranged into convoys (platoons) which permitted a train-like operation and thus extremely high passenger throughputs; in 1991, volumes of over 20,000 passengers per hour per direction were reported[3]. Although efficient in moving people, it was perceived to have a negative environmental and commercial impact by creating a "wall-to-wall" line of buses, especially at intersections and some bus stops. That widespread perception hindered the further expansion of busways in the 1990s.

In 2001, a new city administration initiated a major reform of the bus services, focusing primarily on (a) full fare integration of all buses in the city, using contactless cards, and (b) implementation of a new type of busway (passa-rápido) which aimed to be visually less intrusive

than the earlier ones while still being able to carry high passenger volumes. Most of the new system had started operation by 2004. Similar to Bogotá, single platforms at busway stops in the center of the road serve both directions of movement. As buses can feed in and out from the busway ("open operation"), they need doors both on the left and right; thus additional doors were refitted on the left for about half of the city's bus fleet. Differently from Bogotá or Curitiba, bus stops have low-level platforms, and the fare payment or validation is done inside the bus (each of which has a conductor observing proper passenger movement past the in-vehicle turnstile). The new busway is separated from general traffic by merely a painted line, but automobile drivers are said to be reluctant to encroach on the busway because of a new camera enforcement system. The passa-rápido gives indeed a "lighter" impression but nevertheless is reported, on routes with extra passing lanes at stops, to carry high peak-hour volumes of about 15,000 passengers per hour per direction. However, the "open operation" of a large number of buses is notoriously difficult to control, and "wall-to-wall" bus bunching is again observed on some of the new busways.

Near the city limits (both inside and outside the municipality of São Paulo), the State Government built in the 1980s, and initially operated, parts of a 33 km long circumferential trolleybusway, connecting São Mateus and Jabaquara with suburban towns such as Santo André and Diadema. This operation was concessioned in 2002 to a private consortium which, in addition to operating the services, completed the infrastructure works and is responsible for their maintenance; to our knowledge this is the only full busway concession (anywhere) contracted to a private enterprise. With 78 trolleybuses and 103 Diesel buses, over 200,000 passengers per day use this service, with a peak-hour volume of 21,600 passengers per direction.

Belo Horizonte, Brazil: About 6 km of a median busway were built in 1981 as part of a transport master plan, linked to another 8 km of bus lanes. At its southern end, buses have exclusive use of the lower level of a double-deck tunnel connecting with the city center. The busway has off-line bus stops to permit overtaking, which helps to achieve a high peak-hour volume of 21,100 passengers per direction. Electronic ticketing was to be introduced earlier this decade, and there are plans to build 13 terminals (including 3 with the metro) and an additional 20 km of busways and bus lanes, to form an integrated public transport system with trunk-and-feeder services.

Recife, Brazil: The city has 15.6 km of median busways, 3.4 km of bus lanes, and five bus transfer terminals. The most important busway is on Avenida Caxangá, on which both trolleybuses and Diesel buses operate, reporting a very high peak hour volume of over 20,000 passengers per direction. Recife was the first place in Brazil testing a video camera enforcement system for the bus lanes, and was also pioneering the use of an Automatic Vehicle Identification system.

Campinas, Brazil: A 4.5-km long busway connects with 0.5 km of bus lanes in the city center, linking it to the central bus terminal. Public transport in the city is integrated, following the trunk-and-feeder model. The busway has passing lanes at bus stops and carries a peak-hour volume of 9,200 passengers per direction.

Quito, Ecuador: In the last 10 years, three BRT operations have been implemented, each with distinct contractual and operating characteristics. They run in roughly parallel corridors, reflecting the elongated shape of Quito's main urbanized area. The first and best known is a trolleybus line ("Trole") which began operation in late 1995 and subsequently was extended in 2000. The second and third are the "Ecovía" and "Central-Norte" corridors, both served with Euro II Diesel buses. Summarized in Table 2, the three lines consist of mostly segregated one-lane busways located in the median, have high-platform stops with fare pre-payment, and use articulated buses between the terminals where free transfers are possible to feeder buses.

Table 2: BRT Lines in Quito, Ecuador

	Trole	**Ecovía**	**Central-Norte**[1]
Year opened	1995, 2000	2003	2004
Length (km)	17	9	11
- of which segregated	90%	>95%	95%
+ extensions by 2006 (km)	+1	+4	+8
Number of terminals	3	2	4
Number of intermediate stops	28	16	24
Passing lanes at stops?	no	no	yes
Number of trunk-line buses	113	42	34
- location of bus doors	right	left	right
Number of integrated feeder buses	89	40	67
Commercial trunk-line speed (km/h)	15	17	20
Weekday passenger volume	240,000	55,000	73,000
Infrastructure cost (million US$/km)	1.0[2]	1.2	2.3

[1] Because of the fairly recent busway completion (late 2004), data on bus operations are still quite preliminary. Upon its completion, the Central-Norte system is expected to include 84 articulated trunk-line buses, and 152 standard-sized feeder buses. The weekday flow has been forecast to reach 420,000 passengers.

[2] This covers busway, stations and other civil works. When overhead wires, electrical infrastructure and rolling stock are included, the total cost amounts to US $5.1 million/km.

SOURCE: Dirección Metropolitana de Transporte y Vialidad, Quito, April 2005

The Trole runs mostly on a fully segregated busway, located in the middle of relatively wide avenues, and includes three major terminals permitting free transfers to/from feeder buses. It also passes through the historic city center – included in UNESCO's World Heritage List – which has an intricate system of streets that are rarely wider than two lanes. Here the BRT demonstrates its flexibility, providing high-quality public transport access to an area that is more suitable for pedestrian movement than motor vehicles; however, this comes at the price of a somewhat restricted line-haul capacity (about 8,000 passengers per hour per direction) and a relatively low commercial bus speed (10 km/h in the central area, the main reason why the overall terminal-to-terminal speed is "only" 15 km/h).

Distinct from the other BRT systems in Latin America, the Trole is government-owned and operated; the two more recent Diesel-bus BRT lines are operated by private consortia under 12-year concessions. Unfortunately, there is no operational integration among the three lines at this stage, and passengers cannot transfer between them even though at two locations some lines

pass through the same street. The current arrangements are the result of separate business negotiations with individual groups of private bus operators that had to be coaxed into collaborating with the BRT reform. Quito intends to address this lack of integration which is mostly due to institutional (rather than technical) reasons.

Bogotá, Colombia: TransMilenio is the highest-volume BRT system anywhere, using segregated busways, stations, and terminals adapted to articulated buses (160 passengers), and fare-integrated operations with smaller buses in the outskirts of the city. Similar to Curitiba, the project was not only designed as a transport scheme but was part of a comprehensive city upgrading program to improve public space in general, i.e. sidewalks, parks, bikeways and mixed-traffic streets. The construction costs quoted in this paper include these extra works built in addition to the BRT infrastructure in the corridors in question.

The main four-lane (2+2) busways of TransMilenio were inaugurated in December 2000, less than three years after the system was conceived; another two-lane (1+1) busway opened in August 2001, virtually completing Phase 1 of the project. The new system was rapidly accepted by the population, and has become a model which many transport planners elsewhere are trying to emulate in their cities. The first Phase 2 busway began operation in 2003, and construction is well-advanced on the two remaining busways: they next 10 km are expected to open in August 2005, and Phase 2 should be fully operational in early 2006. Detail planning for Phase 3 is underway. The basic characteristics of Phases 1 and 2 are shown in Table 3.

Table 3: TransMilenio BRT System in Bogotá, Colombia

	Phase 1	Phase 2(a)[1]	Phase 2(b)[2]
Year opened	2000	2003	2005-06[3]
Number of busways	4	1	2
Length (km)	42	13	29
- of which segregated	94%	100%	100%
Number of terminals and transfer stations	8	2	3
Number of standard stations	53	16	34
Number of trunk-line buses	470	137	198
Number of integrated feeder buses	235	146[4]	
Commercial speed (all-stop buses) (km/h)	21	23	n/a
Commercial speed (express buses) (km/h)	32	32	n/a
Weekday passenger volume	770,000	250,000	380,000[6]
Peak-hour directional volume	35,000[5]		32,000[6]
Infrastructure cost (million US$/km)	5.8	10.7	15.2

[1] Avenida Américas
[2] Avenidas Suba & Norte-Quito-Sur
[3] An additional 5.5-km section to suburban Soacha is expected to open in 2007
[4] All of Phase 2
[5] On section of 2+2 lane Avenida Caracas busway
[6] Forecast
SOURCES: See Annex Tables

While the physical aspects of TransMilenio are impressive enough, the main pioneering achievements are its institutional and regulatory features. With the help of a competent professional team and first-rate consultants, a new business model was devised and implemented to reform a chaotic private bus service industry which consisted of thousands of small enterprises

with many individual bus owners and operators. In transparent bidding processes, seven (10-year, based on 750,000 bus-km run) concessions were signed for the trunk-line services of Phases 1 and 2, six (initially 4-year, then 10-year) concessions for the feeder bus services, and two (10-year) concessions for the fare collection services, including the provision of turnstiles and smart cards. The bus concessions, under which the private operator had to procure and finance the buses, proved to be highly successful, so much so that commercial banks, which had been reluctant to enter into this business for the Phase 1 contracts, were keen to provide loans to the winners of the Phase 2 contracts. The originally unexpected profitability of the BRT services can be explained by the much higher bus productivity under the new system: While traditional buses carry less than 350 passengers on a typical weekday, the new trunk line buses serve more than 1,600 passengers per day.

León, Mexico: Operating since 2003, León's "Optibus" BRT systems incorporates some of the features of TransMilenio, with 15 km of centrally located busways, 51 stations with high-level platforms (but without passing lanes), 52 articulated Diesel buses with Euro III technology and boarding through left-hand doors. The three BRT lines, which also include an additional 11 km of bus operation in mixed traffic, feed into terminals which permit transfers with 209 integrated feeder buses.

The project was conceived in 1994 after the creation of the Transport Coordination Entity (TCE), a partnership between 13 bus companies which have since organized their operation into four large companies. The city then created the "Integrated Transport System", a commission which includes representatives of the city, the State, and TCE. Being the first BRT system in Mexico, it has attracted the attention of several cities throughout the country.

BRT Systems Being Implemented in Latin America

Having heard of Bogotá's success with TransMilenio, many Latin American cities are considering the implementation of BRT, and numerous feasibility studies have been or are being carried out. Table 4 and the following text focus on only those cities which have decided to go ahead with BRT, and which have secured financing for at least an initial line. It can reasonably be expected that these systems will start operations between 2005 and 2007.

Mexico City: The Federal District of Mexico intends to inaugurate in mid-2005 a median busway along the 20-km "Insurgentes" corridor, which crosses the District from north to south and intersects with many existing metro lines. One private and one public company will operate 80 articulated buses, with high-level boarding and doors to the left; fares will be paid before entering the stations. Thanks to these high-performance features which were inspired by Bogotá's experience, the busway is expected to accommodate 250,000 passengers per day and permit a commercial speed of 21 km/hour, compared to 14 km/hour achieved by the bus services currently serving the corridor.

Table 4: BRT Systems Being Implemented in Latin America

City and Country	Metropolitan Population(M)	Expected Start of BRT Operations	Number of Busways	Busway Length (km)
Mexico City	22.3	2005	1	20
Pereira, Colombia	0.7	2005	2	16
Guayaquil, Ecuador	2.2	2006	3	45
Santiago, Chile	5.3	2006	3	20
Medellín, Colombia	3.4	2006	1	13
Lima, Peru	8.3	2007	2	32
Cali, Colombia	2.6	2007	5	49
Cartagena, Colombia	1.1	2007	1	12
Barranquilla, Colombia	1.9	2007	1	13
Bucaramanga, Colmbia	1.0	2007	1	8
Guatemala City	2.0	2007	1	11

SOURCES: See Annex Tables

The District government intends to implement additional BRT lines, first among them the "Eje 8" which would be of similar length as the first corridor, but run east to west. Moreover, there are general plans for BRT lines outside the city limits (where more than half of the metropolitan population lives), connecting metro terminals with low-income residential areas.

Guayaquil, Ecuador: The proposed integrated bus system will eventually consist of seven trunk lines, with an overall length of about 100 km. Three lines are under construction, with a total length of 45 km of segregated busway. The first stage will include 105 stations with high platforms, as well as four terminals where free passenger transfer will be possible between articulated trunk-line buses and feeder services. Also during the first stage, 210 trunk line buses (with doors to the left similar to Bogotá) and 232 feeder buses are expected to carry about 490,000 passengers per day, with a maximum peak-hour volume of 12,000 passengers per direction. The project has been delayed somewhat, compared to the original timetable, but it is expected that BRT operations will commence before the end of 2005.

Infrastructure costs for the first stage are estimated to total US$ 120 million (US$ 2.7 million per km) and are partly financed through a US$ 65 million loan from the Andean Development Corporation. Differently from other recent BRT systems, the city government has given the power to regulate and control the bus service concessions to a "City Management Foundation", rather than reserving that function to a municipal department or company. That foundation is legally a private entity, with representatives from the chamber of commerce, the association of banks, the transport sector, the municipal government, the University, and others.

Santiago, Chile: A highly ambitious public transport reform is underway and should be fully operational in about mid-2006. It aims at the rationalization of all urban bus services and their operational and fare integration with the metro system. Under 15 new bus operating concessions, the metropolitan area will be served by nearly 4,700 buses, of which 71 percent will run on trunk-line, and 29 percent on feeder routes. The four metro lines (80 km in length) will

be complemented by three major busway corridors (26 km), in addition to over 30 corridors along which trunk-line buses will operate on mixed-traffic streets. The average cost of the busways and other street improvements (including stops, but without the transfer terminals) amounts to about US$ 2.3 million per km. Differently from all other BRT systems built to-date, where the government paid for all fixed infrastructure, almost two thirds of the new busway investments will be financed by the bus service concessionaires, i.e. ultimately from the fare box.

Similar to São Paulo's Interligado system which also covers all of the city's bus lines, the new Transantiago system will keep many conventional features, such as street-level entry, doors on the right, and fare validation inside the buses. Other aspects will be similar to (say) Bogotá, such as institutional and organizational reform, including fare collection and revenue distribution. The most impressive, indeed pioneering achievement will be the short time in which the entire public transport supply will have been reformed, including the replacement of 7,700 relatively old buses by a much smaller number of new ones – resulting in substantial economic and air pollution benefits (the latter very important in Santiago). A sophisticated route restructuring analysis made it possible to reduce bus supply by 40 percent, while at the same time improving door-to-door travel times for passengers. It is expected that, thanks to much-improved bus routing and scheduling, the costs of bus amortization and operation will be fully recovered from the fare box – without having to increase the existing tariff of 70 US Cents per average trip (including transfers).

Lima Peru: Considered to be part of a broad plan to improve public transport**,** the first BRT corridor will traverse the city from north to south, divided into two separate routes in central Lima – one route serving the historical center and the other bypassing it. A second, 4-km long busway along Avenida Grau will connect with to bus routes toward the east and, possibly, a future rail rapid transit line. There will be 32.3 km of fully segregated busways, half of them four lanes wide (2+2), and half of them two lanes wide (1+1, but with extra passing lanes at stations). It incorporates, and upgrades, the 9-km long Via Expresa busway which had been built in the early 1970s as part of a motorway scheme[4].

Again, this project was inspired by the experience of Bogotá, and will include high-level stations in the median, articulated trunk-line buses with doors on the left, fare prepayment, and major terminals at the two ends were passengers will transfer to/from feeder buses. This should make it possible to achieve high system productivity, and it is expected that 225 trunk-line buses will serve 624,000 passengers per day (2773 per bus!). With joint financing from the Municipality of Lima and loans of the World Bank and the Inter-American Development Bank, it is hoped that BRT operations in the southern half of the line will commence in early 2007.

Colombian Cities: In view of Bogotá's success with TransMilenio, the Colombian government decided in 2003 to promote BRT operations in the smaller metropolitan areas of the country, ranging in population from 0.7 to 3.4 million. It defined a National Urban Transport Project to support BRT development in six cities[5] and to improve accessibility for low-income residents through fare-integrated feeder services. In Medellín, a new BRT line will complement the existing rail rapid transit lines, and in Cali the new BRT system will be built instead of a Light Rail system which had been considered for many years by the city, but which was eventually discarded because of resource constraints.

The national government will pay for about two thirds of the physical infrastructure and the respective cities for about one third; the buses, operational control and fare collection equipment will be financed by private enterprises under concession agreements with each city. The national share is supported by loans from the Inter-American Development Bank (Cali) and the World Bank (other cities). At the time of writing, busway construction had commenced in three cities, and full BRT operation is expected to start before the end of 2005 in one of them (Pereira).

Guatemala City: Financing was approved in early 2005 for an 11-km long BRT line connecting the southern part of the city with downtown. With the assistance of UNDP, bids have also just been issued for the acquisition of the first 20 articulated trunk-line buses, and for a prepaid (contactless) fare system. It is expected that BRT operation will start in 2007.

What is Different about Latin American BRTs ?

Over the last decade, various operational features have been developed and fine-tuned – most of them pioneered in Brazil and Bogotá – which give BRT its distinctive image and high productivity. Among these are feeder-trunk operation, bus overtaking at stops, four-lane (2+2) busways for high-demand corridors, limited stop and express services, high-capacity trunk-line buses (articulated or bi-articulated), high-level "metro-like" entry into buses, often through left-hand doors from centrally located bus stations, and prepayment of fares. Table 5 summarizes these features for the major existing systems, and those that are being implemented.

Layout of Busways: While most early bus lanes and busways were in the curb lanes of major avenues, virtually all new segregated busways have been placed in the median – permitting high commercial bus speeds but requiring passengers to cross the street in order to reach the bus stations. Another innovation are extra bus overtaking lanes at stations, now widely accepted to reduce bus delays and increase busway capacity. Some high-demand busways in Bogotá, Lima and Santiago have two segregated lanes in each direction, even between stations, permitting higher commercial speeds and passenger volumes than observed in most metros – despite the traffic signals at intersections.

While wide avenues are needed so standard busways can be fitted in, there have been several imaginative solutions to adapt BRT-ways to the relatively narrow streets of commercial or historical city centers. Foremost among these is the Quito Trole which passes through a historical center, utilizing many 7-meter wide streets and, in a short section, a street barely wider than 3 meters. The latter has obviously been closed to general traffic, but there are also remarkable and well-functioning bus-only streets in Bogotá and Curitiba, and similar bus-cum-pedestrian streets are being implemented in six other Colombian cities.

Buses and Stations: Except for Santiago and São Paulo, all new BRT systems use buses with high-level entry, about 90 cm above street level, calling for special station platforms of the same height. As a result, passengers can quickly enter and leave the bus – similar to a typical metro – which contributes to the high commercial speeds observed for almost all Latin American

BRTs. Moreover, buses are built on truck chassis and are thus less costly than low-floor buses. Another distinct feature of Latin America's BRTs is the use of very large buses for their trunk routes, either 18-meter long articulated buses with a capacity of about 160 passengers, or the 25-meter long bi-articulated buses of Curitiba and São Paulo, with a capacity of about 260 passengers.

Table 5: Design Features of Latin American BRT Systems

	Trunk and feeder ?	Passing lane at stations ?	2+2 lane busways ?	Express bus services ?	Articulated buses ?	High-level bus entry ?	Bus entry from left ?	Fare pre-payment ?
EXISTING SYSTEMS								
Curitiba	✓	no	no	.(1)	✓(2)	✓	no	✓
Goiânia	✓	no	no	no	✓(3)	✓(3)	✓(3)	✓(3)
São Paulo passa rápido	partly	partly	no	✓	✓(4)	no	✓	no
Quito Trole	✓	no	no	no	✓	✓	no	✓
Quito Ecovía	✓	no	no	no	✓	✓	✓	✓
Quito Central-Norte	✓	✓	no	✓	✓	✓	no	✓
Bogotá	✓	✓	✓	✓	✓	✓	✓	✓
León	✓	no	no	no	✓	✓	✓	✓
SYSTEMS BEING IMPLEMENTED								
Mexico City	✓	no	no	no	✓	✓	✓	✓
Pereira	✓	✓	no	✓	✓	✓	✓	✓
Guayaquil	✓	no	✓(5)	✓	✓	✓	✓	✓
Santiago	✓(6)	no	✓	no	✓(7)	no	no	no
Medellín	✓	no	no	no	no	.(8)	✓	✓
Lima	✓	✓	✓	✓	✓	✓	✓	✓
Cali	✓	✓	no	✓	✓	✓	✓	✓
Cartagena	✓(6)	✓	no		✓(7)	✓	✓	✓
Barranquilla	✓	✓	no	✓	✓(7)	✓	✓	✓
Bucaramanga	✓(6)	✓	no		✓(7)	✓	✓	✓

(1) Curitiba operates express services on mixed-traffic streets parallel to, but separated from, the busway corridors.
(2) Bi-articulated buses.
(3) Only on the Anhangüeira busway (13.3 km, built after 1998).
(4) Bi-articulated, single-articulated and standard buses all operate on the passa-rápido corridors.
(5) 2+2 lane busways on 7 km of segregated corridor. The remaining 38 km will be 1+1 lane busways without passing lanes at stations.
(6) Some trunk-line buses will also serve passenger stops on mixed-traffic streets.
(7) Articulated and standard buses are planned to operate on the busway.
(8) Not yet decided as of April 2005.
SOURCES: see Annex Tables

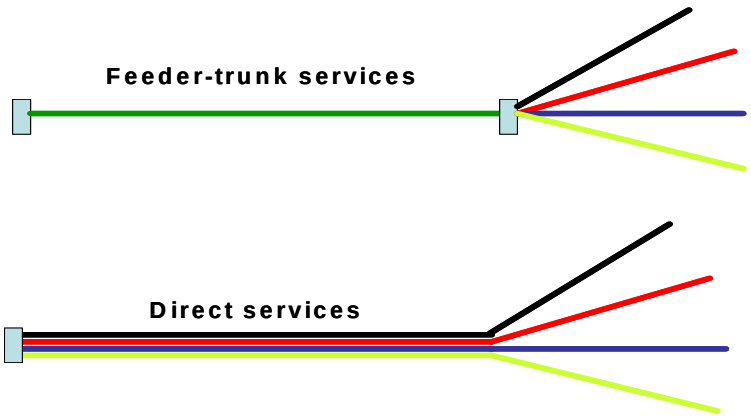
The first two large-scale BRTs (Curitiba and Quito's Trole) had the bus doors on the "conventional" side, i.e. the right. In 2000, Bogotá's TransMilenio applied the concept of two-directional bus stations in the road median, requiring left-hand doors for all trunk-line buses. The advantages of that arrangement, i.e. savings in physical space and station personnel, were so

obvious that almost all new systems, with the exception of Santiago and Quito's third busway, have been using the left-door standard. As shown in the table above, three of the new BRTs will operate trunk-line buses beyond the busway terminals to serve passenger stops in mixed-traffic streets; a second set of step-down right-hand doors will thus be added to the buses serving those stops (in Cartagena and Bucaramanga; Santiago has right-hand boarding throughout the system).

Metros throughout the world have their passengers purchase or validate their tickets before reaching the station platform, thus permitting rapid entry into the metro car. Partly for the same reason, all but two of the new BRTs (the exceptions being São Paulo and Santiago) require fare prepayment before entering the bus station. Goiânia estimates that, once passenger flows exceed 2,500 passengers per hour per direction, the delays associated with on-board fare collection (instead of prepayment before entry into the station) become a significant system liability.[6]

Feeder-Trunk Bus Services: When planning the BRT systems, much thought has been given on how to combine bus services in the high-flow corridors radiating from the city center with those in lower-density zones. As detailed in a new BRT Planning Manual[7], there are two basic options:

- Feeder-trunk services, sometimes also called "closed system", whereby high-capacity buses operate only on trunk busways ending in terminals where passengers transfer to/from smaller feeder buses, and
- Direct services, sometimes also called "open system", whereby trunk-line buses go beyond the busway, or leave it at intermediate points, providing direct service to outlying zones.



Experience with traditional busways in Brazil, Bogotá (pre-2000) and Lima demonstrated that it is difficult to control trunk-line operations under an open system, with "bunching" of vehicles occurring along the busway which can severely reduce commercial speeds. In the planning of almost all recent BRTs, it was concluded that the transfer time penalty incurred under the closed system would be more than offset by the higher commercial speed along the main busways. Even in Santiago and São Paulo's passa-rápido system, which have chosen to operate under an open system, most trunk line buses terminate at outlying terminals where passengers can transfer to local bus services.

Limited-stop and Express Bus Services: Often, relatively few major stations predominate as the intended destination of customers. For many passengers, stopping at each intermediate station adds significantly to the overall travel time with relatively little commercial benefit to the system operators. Thus, both passengers and operators can benefit from the provision of services that skip intermediate stops. Similarly, express services that skip all stations between a peripheral area and a central district can provide a high-grade passenger service while simultaneously raising bus productivity.

Bogotá's TransMilenio has been demonstrating the merits of limited-stop and express services, with more than half of its passengers using one of ten such services which operate at an average commercial speed of 32 km per hour – despite frequent stops at traffic signals along the route; this is equal to or faster than 7 of the 14 metro systems in developing countries studied in 1990 by TRRL.[8] It is expected that Lima's new BRT will also make extensive use of limited-stop services, as well as several of the Colombian cities where such systems are being implemented.

While limited-stop services provide much amenity value to the passenger, they introduce greater complexity in managing the coordination of vehicles on the same corridor with different travel characteristics. Limited-stop services thus work best in conjunction with vehicle tracking technology that permits a central control team to oversee and direct vehicle movements. Both Bogotá and Lima include real-time control, using GPS technology. Bogotá also employs station assistants to help passengers with the confusing array of possible combinations of local and limited-stop services along the same corridor.

Access for Persons with Disabilities: The level bus access from high-station platforms has opened new opportunities to provide public transport for wheelchair users or others with walking disabilities. A recently published manual for inclusive design in the transport field singles out the BRTs of Curitiba, Bogotá and Quito as good examples.[9] The station platforms of all BRTs are accessible from the ground level via ramps or, in the case of Curitiba, small lifts; additional features include one turnstile per station wide enough for wheelchairs, audio announcements and tactile strips for blind people, and station assistants to help persons with perceptive disabilities. In the context of the new systems being implemented in six Colombian cities, a study is currently underway to define specific inclusive design guidelines for BRTs.

Institutional Aspects: For many decades, bus services in Latin American cities have been provided by private operators, in most countries without effective regulatory control. This laissez-faire approach has resulted in a chaotic and inefficient bus oversupply. Before the introduction of TransMilenio, Bogotá had over 30,000 buses plying the streets, and in Lima the number was estimated at 50,000 vehicles. In this context, the introduction of BRT systems (outside Brazil which has a history of formal bus companies) has been intrinsically linked to a reform of the public transport industry.

With the exception of Quito's Trole which is managed by a municipal company, bus services of all Latin American BRTs are operated by private firms or cooperatives, rather than the traditional owner-operators and service brokers. The individual contracting arrangements

vary, but in most cases involve an autonomous municipal department or company that is responsible for the planning, contracting and supervision of the services. Thanks to strong and coherent municipal leadership, assisted by first-rate management consultants, Bogotá has developed an organizational and business framework which is widely considered as a model, and which is one of the reasons for TransMilenio's success. The following are excerpts from a recent TRB paper[10] which summarizes well that experience and compares it to some other Latin American examples:

> Public funds for TransMilenio were only used for planning and infrastructure. Funds for constructing the exclusive bus lanes, the enclosed bus stations, the terminals, the control center and part of its GPS, and the sidewalks and bicycle paths in the same corridor, were paid for by public..... TransMilenio requires no operating subsidies and earns substantial profits for its operators. Like in Curitiba and León, but unlike in Quito ……. , Bogotá did not spend any money on bus procurement. Nor did it provide any municipal bank guarantees.
>
> This long-term economic and financial sustainability beyond the initial capital investment *reflects* …… the primary goal of the planning process from inception to implementation. …… Knowing that the system had to be financially self-sufficient, it was accepted from the outset that the introduction of TransMilenio would require a fundamental transformation in the existing route licensing system for private operators. Unlike in Curitiba, where private bus consortiums were given concessions over areas historically under their control, Bogotá wanted more control over the contracting process. ……
>
> TransMilenio's contracts with the trunk line operating companies were written in such a way that the demand risk (the risk that ridership would be lower than anticipated) was reasonably evenly divided between the city and the operating companies. Because trunk line operators are paid by the bus kilometer, they are certain to be paid a certain amount regardless of demand. However, they ultimately bear some of the demand risk, because if the demand is lower than projected, TransMilenio *S.A.* has the right to reduce the total number of bus kilometers servicing the system. On the other hand, the contract allows for them to extend the period of the concession. The concession contract lasts for 10 years or until the average kilometers per bus reaches 750,000, whichever comes first. However, if after ten years the average is not achieved, the concession is extended until it reaches that average. So, the possibility of extending the concession allows the investor to eventually recoup their bus investment in the case of lower than estimated demand, although they would recoup it over a longer period of time. In practice this has not been a problem, as demand has actually been in excess of what was anticipated
>
> In this way, the operating companies had a vested interest in maintaining a good quality of service and promoting the system, in order to retain ridership. This was even more true for the feeder bus operators who were initially paid *per* passenger during Phase I. During Phase II, the feeder bus operators complained

that they were exposed to the full demand risk, and successfully had the concession terms changed to a combination of payment per kilometer and payment per passenger.

The fact that the private operators were exposed to some demand risk initially made it difficult for the private operating companies to obtain loans from banks for the procurement of the buses. These were newly formed corporate entities with no formal credit history, and despite the personal appeals of the Mayor, the Colombian banks refused to finance their bus procurement. Ultimately, the loans were procured from the Brazilian export credit agency, as the buses being procured were initially assembled in Brazil. In the subsequent phases, after TransMilenio's profitability has been clearly demonstrated, private operators have had no difficulties securing private bank loans for bus procurement.

Unlike *in conventional bus* systems, in TransMilenio neither the trunk line operators nor the feeder bus operators directly collect any fares. In Bogotá they are collected by a separate company. The smart cards and turnstiles are amortized over the time of their concession and will later revert to TransMilenio *S.A.*. The revenues go into a trust fund controlled in the name of TransMilenio *S.A.* by another contractor, a financial service provider, who in turn invests the money and distributes it among the partners. The stations, meanwhile, are maintained by TransMilenio *S.A.* under contract to private companies.

The funds are collected by a private company not allied with any of the bus operating companies in order to ensure fairness between the various private operating companies. This private control also insulates the system somewhat from the political process. In the TransMilenio system, the profits cannot be diverted directly from the system to other public uses. The government is allowed to reduce the passenger fare below the technical fare, but in this case the government has to pay the operating companies compensation. In this way, TransMilenio is insulated from the threat of disinvestment from the system by politicians. The only part of the farebox revenue directly under the Mayor's control is th*e* share that goes to TransMilenio *S.A., about* 4% of the total.

Have the Latin American BRTs been Effective ?

Most new-style BRTs are less than 10 years old, and perhaps it is premature to be definitive about their long-term sustainability. Nevertheless, much has been thought about and many data have been collected on TransMilenio since it started operation in 2000. Combining this with the long-term success of Curitiba, one can be certain that BRT is not only here to stay, but also likely to be replicated in many cities which want to improve public transport and urban mobility. The Latin American experience shows that BRTs can be highly productive in moving passengers, at a fraction of the cost of other high-capacity modes; moreover, BRTs can create a new, more attractive image for road-based public transport and, almost invariably, have enormously raised the political standing of the Mayors responsible for their implementation.

Productivity of BRTs: Particularly Curitiba and Bogotá have shown that, despite the BRTs' at-grade alignment through signalized intersections, it is possible to accommodate high levels of passenger demand which previously, and by many professionals still now, were thought to be manageable only by rail mass transit – and that at fairly high commercial speeds (ranging from 15 to 32 km/h). Curitiba and the busways in some other Brazilian cities are consistently carrying peak volumes of over 14,000 passengers per hour per direction (pphpd); over 20,000 pphpd are possible if an extra passing lane is provided at bus stops. TransMilenio's double-width busway on Avenida Caracas even accommodates 35,000 pphpd with a mixture of all-stop and express bus services.

Table 6 shows the daily passenger volumes estimated for nine BRT systems, some of them still under implementation. In early 2006, five years after the initial line opened, Bogotá's TransMilenio is expected to carry 1.4 million passengers per day, exceeded in Latin America only by the Mexico City and São Paulo metros which, however, took more than three decades to build. Per kilometer of busway, the productivity ranges from about 6,000 passengers per typical weekday on Quito's relatively underutilized Ecovía to over 18,000 passengers per day in Bogotá (observed) and Lima (forecast). Station volumes range from an average of about 3,000 passengers entering Ecovía's 18 stations to over 12,000 passengers entering the 61 stations of Bogotá's TransMilenio Phase 1.

Table 6: Productivity of Latin American BRT Systems

	Passengers per Day	Km of Corridor	Trunk Buses	Pass. per Km	Pass. per Bus
EXISTING SYSTEMS or LINES					
Curitiba	532,000	65	247	8,235	2,154
São Mateus – Jabaquara (SP)	207,000	33	189	6,273	1,095
Quito Trole	240,000	17	113	14,201	2,124
Quito Ecovía	55,000	9	42	6,180	1,310
Bogotá Phase 1	770,000	42	470	18,160	1,638
SYSTEMS BEING IMPLEMENTED					
Bogotá Phase 2	630,000	42	335	14,894	1,881
Bogotá Phase 1+2	1,400,000	85	805	16,529	1,739
Mexico City	250,000	20	80	12,500	3,125
Pereira	150,000	17	51	8,982	2,941
Guayaquil	490,000	45	210	10,889	2,333
Lima	624,000	32	225	19,319	2,773

SOURCES: see Annex Tables.

Few traditional bus operations in Latin America carry more than 500 passengers per bus per day, whereas most existing and future BRTs have, or are expected to have, daily productivity ratios approaching or exceeding 2,000 passengers per bus. These high values reflect primarily (a) the fast turn-around of buses which on the segregated busways are not affected by traffic

congestion and which benefit from the quick passenger entry/alighting at metro-like BRT stations, and (b) the relatively large size of the articulated buses used. When calculating the commercial productivity of BRT operations, rather than using the relatively crude measure of daily passengers per bus, it has become common practice to calculate the Index of Passengers divided by bus-Kilometers run per day (IPK). These values are not always available, but typically are greater than 6 and can even reach the high value of 14 (for Quito's Trole, reflecting relatively short passenger trip lengths, and bus overcrowding).

The Financial Dimension: The costs of BRT implementation can vary considerably, as evident from the per-kilometer costs shown in Table 7. On the low side are the fairly frugal systems of Curitiba and León; at the other extreme, the relatively high expenditures for TransMilenio include substantial sums for mixed-traffic streets, grade-separated interchanges and public space improvements. When related to the countries' economic capacity, using the Gross National Income per capita as a proxy, this gap is even greater. The unit costs for Quito's Trole and Lima lie in the middle, reflecting the relatively high costs of electrical infrastructure and mixed-traffic improvements, respectively.

Table 7: Implementation Costs of BRTs in Latin America

	Costs per km[(1)] of Busway (million $)	**Country GNI per Capita** (2003)	**Costs/km divided by GNI/Capita**
Curitiba	1.4	2,720	515
Quito Trole	5.1	1,830	2,787
Bogotá Phases 1+2	11.9	1,810	6,595
León	1.4	6,230	225
Guayaquil	3.6	1,810	1,967
Lima	5.5	2,140	2,570
Pereira	2.7	1,810	1,492

(1) Including costs of infrastructure and vehicle acquisition (the latter by private bus operators, except for Quito).
SOURCES: see Annex Table

The previous table demonstrates that the initial investments for BRTs are much lower than that for metro systems which typically range from US$ 40 to 90 million per kilometer of line[11]. Moreover, the BRTs described in this paper (with the exception of Quito's Trole and Ecovía) cover operating costs including vehicle acquisition and depreciation from passenger revenues – different from almost all urban rail systems in Latin America and elsewhere. Table 8 shows the current fares and examines, to what degree there may be an issue of affordability for low-income persons, again using the countries' GNI per capita as a proxy[12]. It highlights that fares are most affordable in Mexico and Ecuador, where the Governments have been following a policy of low public transport fares, often resulting in vehicle overcrowding and the potential dilemma of public subsidies and/or service deterioration. On the other hand, the relatively high fares of Bogotá may – and probably do – divert some low-income passengers to informal transport modes, or deter them from traveling altogether. In Brazil, the high standard fares are mitigated by the "vale-transporte" system under which companies are obliged to pay part of their low-wage employees' commuting costs.

Table 8: Affordability of Latin American BRT Fares

	Fare in US Cents (Apr 05)	**Country GNI per Capita** (2003)	**Fare Affordability Index** (500 trips divided by GNI/cap)
Curitiba	74	2,720	13.6%
Goiânia	59	2,720	10.9%
São Paulo	78	2,720	14.3%
Quito	25	1,830	6.8%
Bogotá	52	1,810	14.4%
León	45	6,230	3.6%
Santiago	70[(1)]	4,360	8.0%

[(1)] Average cost per existing public transport trip, including consideration of double payment when transferring between modes
SOURCES: see Annex Table

Public Acceptance of BRTs: As in many developing countries, urban public transport in Latin America is generally operated by private firms or individuals, usually under franchises given by the municipal governments. On the positive side, this approach usually avoids the need for government subsidies, creates work opportunities in a generally underemployed labor force, and furthers a culture of private enterprise. On the other side, it can create strong vested interests, often becomes a major factor in public corruption and, perhaps surprisingly, helps to generate a transport oversupply which is inefficient, polluting, and highly unpopular among the traveling public. But as the owners of buses and bus route permits are often very powerful, their opposition to reform can be one of the major challenges of implementing a BRT system. Quito's experience illustrates the problem, and how it was overcome[13]:

When Quito's Trole started operations, conventional bus routes running parallel to the new trolleybus line were reorganized as part of the overall rationalization plan, some 60 percent being transferred more than 100 meters from the main corridor. The existing bus companies and transport cooperatives were naturally opposed to the new scheme. Moreover, the political opposition parties were openly in disagreement with the project and tried to confuse public opinion about the usefulness of the new system. A much repeated argument was that rail technology should be used to "solve the urban transport problem" – a point sometimes raised by the status-quo lobby as the enormous cost of rail solutions conveniently sidelines any discussion on public transport reform.

Several months after the Trole opened, the traditional bus operators went on strike and, by blocking most key intersections with their vehicles, paralyzed the city for four days. Eventually the strike fizzled, partly due the threat of intervention by the Army, but perhaps primarily due to a lack of civic support. The popularity of the Mayor skyrocketed, and later he was elected President of Ecuador. A similar political boost had been experienced by the multi-term Mayor of Curitiba, who subsequently was elected State Governor of Paraná. And more recently, in Bogotá, the Mayor responsible for the creation of TransMilenio left office (the Constitution does not permit re-election) with one of the highest approval ratings ever – primarily because of the positive citizen's response to the new public transport system. These three examples illustrate the strong public acceptance that can be achieved by BRTs.

What about Metros? Rail rapid transit services exist in 15 Latin American cities, most of them built between 1970 and 2000. The BRT lines of São Paulo and Santiago are to be considered as important complements to the expanding metro systems in those cities, and there will be full tariff integration for all public transport services, including non-BRT bus lines. Similarly, the BRT lines under construction in Mexico City and Medellín are mere additions to existing metro systems. However, the development of BRT technology has changed the equation and is affecting the decisions on new metro start-ups, as illustrated by the cases of Bogotá and Curitiba.

In Bogotá**,** shortly before TransMilenio was conceived, a major study was completed to build a 30-km long metro line, a scheme that had initial support from both the national and municipal administrations. However, there was concern about the financing of the US$ 3,000 million project, which would have consumed over 30 percent of the disposable national budget over the planned construction period of eight years. Eventually, the decision was taken to build the first 42 km of TransMilenio, at a government expenditure of one twelfth the metro line. A benefit-cost calculation conducted two years later[14] yielded a negative Net Present Value for the Metro line, at a 12% discount rate, versus a NPV of US$ 1,000 million for the completed TransMilenio system; the Benefit/Cost ratios were calculated as 0.97 for the Metro, and 2.07 for the BRT.

Curitiba, in 1992, faced severe overloading on its north-south busway and planned to convert the corridor to a Light Rail Transit operation. After much discussion, it decided to shelve the LRT and instead introduce bi-articulated buses and upgrade the busway to the type of operation that is now called BRT. As reported in 2000[15], "the main reason for that decision was cost: the 21-km LRT system would have cost US$ 400 million to build and taken at least two years to be completed. The bi-articulated project cost only US$ 40 million and was operating in 6 months – with far less civil works, route correction and public investment. As private companies run the buses, the largest part of the total investment (US$ 30 million) was financed by the private sector." To boot, few at-grade rail systems reach Curitiba's peak hour volumes of over 14,000 passengers per direction – higher than any LRT line in other developing cities[16].

Conclusions

After some Brazilian cities built the first busways in the 1970s, there were relatively few new developments in upgrading road-based public transport until the early 1990s when Curitiba improved its system to standards akin to what is now termed BRT. Then, taking Curitiba as a model, Quito and Bogotá adapted BRT to their cities. Particularly after TransMilenio's stunning success, many politicians and planners took notice and, as a result, 12 additional cities in Latin America have built or are implementing their own versions of the BRT concept. Many more are considering or studying similar projects. The lessons learned from the experiences can be summarized as follows:

- The public investment cost is much lower than that for other mass rapid transit technologies – often less than one-tenth per km of line. Therefore it is often possible to

finance and quickly build fairly large systems, e.g. 84 km of corridor in Bogotá (1999-2006) and 45 km in Guayaquil (2003-2006).

- Operating costs – including the acquisition of new buses by the private operators – are almost always covered from the fare box; thus there are no recurrent public subsidies.
- Thanks to the segregated busway, BRTs are not affected by increasing traffic congestion which is likely to worsen in most cities because of rising car use.
- Despite the interruptions at signalized intersections, the line-haul capacity of BRT is surprisingly high – up to 20,000 passengers per lane per hour. There are only few cities which have higher corridor demands.
- Where buses are able to overtake each other – as is the case in most new BRT systems – express services can be provided which permit much reduced travel times for passengers.
- The flexibility of BRT also permits corridor alignment through narrow streets and historical areas – albeit at reduced capacity and speed.
- Besides its physical dimensions, BRT involves many institutional, financial and legal aspects, and attention must be given to image and public relations. Moreover, its implementation may encounter opposition from established bus operators. It is clear that good planning and strong political leadership are needed to overcome possible hurdles. On the other hand, such leadership is often rewarded by public acclaim and re-election to office.
- Similar to metros, BRT can have a positive impact on land-use development, an aspect that was not examined in this paper. Much has been written on Curitiba's urban growth which has been substantially shaped by the busway axes. There are now initial signs of similar effects in Bogotá.

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[2] Jorge Rebelo, Basic Busway Data in Latin America, World Bank, 2003.
[3] Geoff Gardner, Phil Cornwell and John Cracknell, op.cit.
[4] The Via Expresa busway was Latin America's first busway. In the early 1970s, Curitiba designers visited Lima to study the then revolutionary project.
[5] In addition to the six cities (Medellín, Cali, Barranquilla, Cartagena, Bucaramange and Pereira), the NUTP also supports the extension of TransMilenio into the Municipality of Soacha, which is located just outside Bogotá's city limits.
[6] Bus Rapid Transit Planning Manual, Gesellschaft für Technische Zusammenarbeit (GTZ) and Institute for Transportation and Development Policy (ITDP), not yet published.
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[11] Cities on the Move, a World Bank Urban Transport Strategy Review, Washington, 2002.
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[13] Sources: Alan Cannell, Transport Consultant, Curitiba, and César Arias, Transport Consultant, Quito.
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Annex Table A: Characteristics of Existing BRT and Busway Systems (as of April 2005)

	Bogotá Phase1	Bogotá Phase 2	Quito Trole	Quito Ecovía	Quito Central-N	Curitiba	Goiânia	Belo Horizonte	Porto Alegre.	Campinas	SãoPaulo pre-2003	SãoPaulo passa-rápido	São Mateus. Jabaquara	Recife	León
main sources	(5)	(5)	(6)	(6)(7)	(6)	(8)(11)	(8)	(8)	(8)	(8)	(8)	(8)(9)	(8)	(8)	(10)
metrop population (millions)[1]	8.1	8.1	1.6	1.6	1.6	3.1	1.9	5.4	4.0	2.6		20.0		3.7	1.4
2003 country GNI/capita ($)[2]	1810	1810	1830	1830	1830	2720	2720	2720	2720	2720		2720		2720	6230
year opened	2000	2003	1995	2003	2004	1974	1976	1981	1977	1985	1979	2003		1982	2003
number of busways	4	3	1	1	1	6	2	1	8	1	3	7	1	3	3
length in km, of which:	42.4	42.3	18.4	12.9	19.2	64.6	35	13.9	50.2	5.0	29.2	111.8	33.0	19.0	26
-- fully segregated busway	39.7	42.3	16.0	12.6	18.6			5.9	26.9	4.5	19.8		30.0	15.6	14.9
-- yet to open (within 12 months)		29.3	1.5	4.0	8.5										
-- dedicated bus streets ?	✓	-	**Short street**	-	-	✓	-	-	-	-	-	-	-	-	-
-- BRT in mixed-tr. Streets	2.7	-	2.4	0.3	0.6	✓		6.0	23.3	0.5	9.3		3.0	3.4	11.1
2+2 lane busways	25.4	10	-	-	-	-	-	-	-	-	-	-	-	-	-
1+1 lane busways	14.3	32	16.0	12.6	18.6		all	5.9	28.9	4.5	19.9	111.8	30.0	15.6	14.9
asphalt or concrete pavem't	c(35)+a	c	a	c	c	a									
nr of terminals+transfer stations	8	5	3	2	4	16	5			6	14		9	5	2
number of standard stations	53	50	28	16	24	107	19	15	128		49				51
Extra passing lane at station	✓	✓	-	-	✓	-	-	✓	-	partly	partly	partly	✓	partly	-
central platf, left bus doors	✓	✓	-	✓	-	-	partly	-	-	-	-	✓	-		✓
pre-boarding fare collection	✓	✓	✓	✓	✓	✓	partly	partly	-	-	-	-	-	-	✓
high-level boarding	✓	✓	✓	✓	✓	✓	partly	-	partly	-	partly	-	-	-	✓
number of trunk-line buses	470	335	113	42	34	247							181		52
-- of which articulated	all	all	all	all	all	bi-articl.	partly					many			all
number of feeder buses	235	146	89	40	67										209
wkday passengers (thousands)	770		240	55	73	532					274		207		
max, peak volume ('000 pphpd)	35		8	3.7	4.5	14.3	11.5	21.1	14.3	9.2	17.7	15	21.6		
av'ge commercial speed (kph)	26	30	15	17	20	19	18	27	15	18	16		22	20	
express bus services ?	✓	✓	-	-	✓	-	-		-			✓			-
fare (US Cents)[3]	52	52	25	25	25	74	59	64	68			78		59	45
infrastr. Cost (million $ per km)	5.8	13.8	1.0	1.2	2.3	0.3						1.1			1.0
total cost (million $ per km)[4]	8.0	15.4	5.1	2.1	3.3	1.4									1.4

SOURCES:

(1) www.citypopulation.de -- for 1/1/2005 (2) World Development Indicators database, World Bank, Washington, May 2005 (3) Fares as of March-April 2005; currency exchange rates as reported in The Economist of 16-22 April 2005

(4) infrastructure cost plus US$ 300,000 per bi-articulated bus and US$ 200,000 per articulated bus (5) TransMilenio S.A., Bogotá, April 2005; Darío Hidalgo, Akiris, Bogotá, April 2005; and World Bank data

(6) Dirección Metropolitana de Transporte y Vialidad, Quito, April 2005 and World Bank data (7) Tranasoc, Análisis Operacional Año 2005 (data for January 2005) and www.sutp.org/network/brt/brtress.htm

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Annex Table B: Characteristics of BRT Systems being Implemented

	Mexico City	Pereira	Guayaquil	Santiago	Medellín	Lima	Cali	Cartagena	Barranquilla	Bucaramanga	Guatemala City
main sources	(4)	(5)(6)	(11)	(12)	(5)(7)	(13)	(5)	(5)(8)	(5)(9)	(5)(10)	(14)
Metropolitan population (millions)[1]	22.3	0.7	2.2	5.3	3.4	8.3	2.6	1.1	1.9	1.0	2.0
2003 country GNI/capita ($)[2]	6230	1810	1830	4360	1810	2140	1810	1810	1810	1810	1910
year expected to open	2005	2005	2006	2006	2006	2007	2007	2007	2007	2007	2007
number of busways	1	2	3	3	1	2	5	1	1	1	1
bus corridor length in km	20	16.7	45	26.3	26	32.3	49	14.6	13.4	22.1	11
-- of which segregated	20	15.7	45	19.9	13	32.3	49	12	13.4	7.5	
-- dedicated bus streets ?	-	✓		-	✓	-	✓	✓	✓	✓	
-- BRT in mixed-traffic streets	-	✓	-	✓	✓	-	-	✓	-	✓	
2+2 lane busways (in km)	-	-	7	17	-	18	-	-	-	-	
asphalt or concrete pavement	a	c	c		c	a	c	c		C	
number of terminals+ transfer stations	2	2	4	11	6	4	9	1	2	4	
number of standard stations	34	37	105		16	38	77	17	16	10	
extra passing lane at stations	-	✓	-	-	-	✓	✓	✓	✓	✓	
central platforms, left bus doors	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	
pre-boarding fare collection	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	✓
high-level boarding	✓	✓	✓	-		✓	✓	✓	✓	✓	
number of trunk-line buses	80	51	210		72	225	163	90	102	140	20
-- of which articulated	all	all	all	some	-	all	all	56%	61%	29%	all
number of feeder buses	16	81	232		26	237	840	100	240		
estim. weekday passengers (thousands)	250	150	490		130	624	1470	490	313	250	
estim. max. peak volume ('000 pphpd)	5.5	3.5	12	37	5.4	15	10	13	11	8	
Est. average commercial speed (kph)	21		22		21		21	20	19	22	
express bus services ?	-	✓	✓	-	-	✓	✓		✓		
est. infrastructure cost (million $ per km)	1.5	1.9	2.7	2.3	4.5	4.1	5.5	6.7	4.8	3.4	
estimated total cost (million $ per km)[3]	2.3	2.7	3.6		5.1	5.5	6.2	7.7	6.0	4.2	

SOURCES:

(1) www.citypopulation.de -- for 1/1/2005 (2) World Development Indicators database, World Bank, Washington, May 2005 (3) infrastructure cost plus US$ 200,000 per articulated bus and US $ 100,000 per standard bus

(4) www.gobrt.org; EMBARQ, World Resources Institute Washington; Centro de Transporte Sustentable de México, May 2005 estimates; and World Bank data (5) Colombian Ministry of Transport, Bogotá, April 2005 estimates; and World Bank data

(6) Megabús, Pereira, April 2005 estimates (7) Metroplús, Medellín, April 2005 estimates (8) Transcaribe, Cartagena, April 2005 estimates (9) Transmetro, Barranquilla, April 2005 estimates (10) Metrolínea, Bucaramanga, April 2005 estimates

(11) César Arias, Transport Consultant, Quito, April 2005; and Plan de Transporte Masivo para Guayaquil, Sistema Troncalizado, 2005 (12) Transantiago, Infraestructura, November 2004; Transantiago, Infraestructura Priorizada 2006, and World Bank data

(13) Protransporte, Lima, April 2005 estimates; and World Bank data (14) www.transmetro.municipalidaddeguatemala.gob.gt and emails from Institute for Transportation and Development Policy, New York, April 2005