

**BUS RAPID TRANSIT AND OTHER BUS SERVICE
INNOVATIONS
BOGOTÁ'S BUS RAPID TRANSIT SYSTEM:
TRANSMILENIO**

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Senate Committee on Banking, Housing, and Urban Affairs
June 24, 2003

I. ABSTRACT

Mr. Chairman and Members of the Committee, my name is Oscar Edmundo Diaz, and I am the assistant to Enrique Penalosa, former Mayor of Bogotá and the Administrative Director of the Institute for Transportation and Development Policy. I thank you for the opportunity to testify before the Committee on Banking, Housing and Urban Affairs on the Bus Rapid Transit system we implemented in Bogotá, Colombia. I hope this testimony provides useful information for the reauthorization of the Transportation Equity Act for the 21st Century (TEA-21) and the inclusion of BRT programs.

Bogotá is a 7-million inhabitant city, in which growing car use began to deteriorate urban quality of life. This was compounded by a need

for a better mass transportation system. Yet all it had was a chaotic fleet of 25,000 almost individually owned buses. Most buses were old and polluting. Drivers worked more than 12 hours daily; racing against other buses for passengers, which led to accidents and the practice of dropping passengers in the middle of the road. Drivers would even block the three lanes of an arterial road so as to impede buses coming from behind from overtaking them. Due to the congested and chaotic system, buses were very slow. This system was bad for the city, for passengers, for drivers and even for bus owners, as it was not a profitable system. Nonetheless, a majority of citizens were forced to take such buses for their daily transport. A version of this exists in most developing country cities.

Mayor Enrique Peñalosa created from scratch a bus-based transit system that transformed the quality of life in our city: TransMilenio. Learning from Curitiba, TransMilenio encompassed specialized infrastructure and permanent supervision provided by local government agencies, and organized operations and advanced fare collections systems under contract with private firms. This bus rapid

transit system has changed Bogotanos lives, not only as mass transportation system, but also as a renewal of the city.

II. BUS RAPID TRANSIT DEFINITION

A Bus Rapid Transit is essentially a surface metro system that utilizes exclusive segregated bus lanes. A Bus Rapid Transit (BRT) is high-quality, customer-orientated transit that delivers fast, comfortable and cost-effective urban mobility.

The main characteristics of BRT systems include¹:

- Segregated busways;
- Rapid boarding and alighting;
- Clean, secure and comfortable stations and terminals;
- Efficient pre-paid ticket;
- Effective licensing and regulatory regimes for bus operators;
- Clear and prominent signage and real-time information displays;
- Transit prioritization at intersections;
- Modal integration at stations and terminals;
- High quality public pedestrian spaces;

¹ Wright, Lloyd. "Bus Rapid Transit", Sustainable Transport: A Sourcebook for Developing Cities, GTZ, Germany, 2003

- Clean bus technologies;
- Sophisticated marketing identity; and
- Excellence in customer service.

When Enrique Peñalosa became the Mayor of Bogotá, he discovered a Transportation Master Plan funded by the Japanese International Cooperation Agency (JICA). The plan's main proposals to solve Bogotá's traffic jams consisted of a metro system and elevated highways. At this time, Bogotá had one busway in Caracas Avenue, which did not work well. However, Mayor Peñalosa also discovered a contract to build another busway like the one in Caracas Avenue in Calle 80. This contract was going to be paid partially with a World Bank loan.

Avoiding or minimizing conflicts is one reason why many developing country cities prefer to invest in much more expensive rail systems than go to the trouble of putting bus-based transit in place. Some other reasons to choose rail include:

- Rail can have a larger capacity, though TransMilenio moves more passengers per kilometer than most rail systems. Bus

- systems can also install a parallel line nearby at a low cost and nearly duplicate capacity; and
- Rail systems project an image of modernity. In cities sated with disastrous bus systems, citizens at first might not want buses and prefer an advanced rail model.²

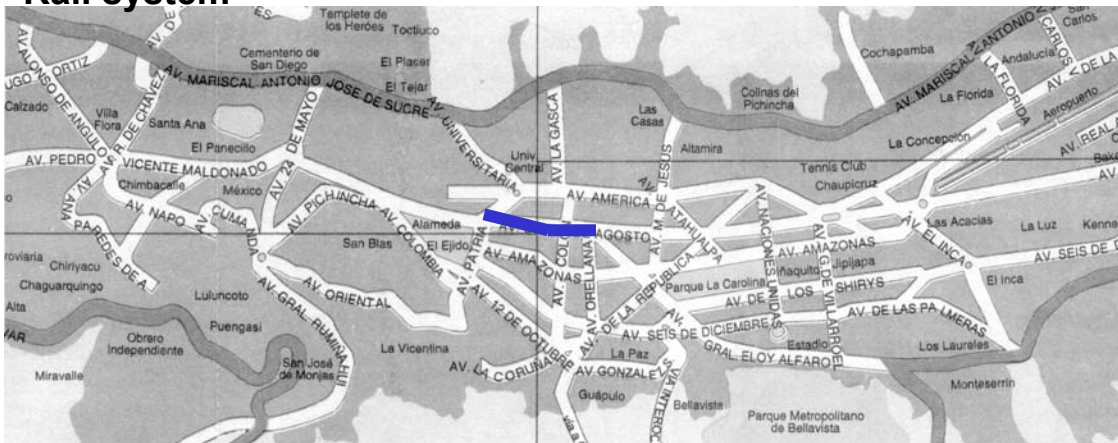
However, Peñalosa decided not to build a metro system. Even if a one or two rail lines are put in place, buses will remain the only possible means to provide public transport to the majority of citizens of a developing country city. Rail system costs are very high. No subway in a developing country has cost less than \$ 100 million per kilometer, a dubious investment in cities where many do not have even sewage, schools or access to parks. For the cost of one subway lane, it is possible to provide quality bus rapid transport to a whole city. **(Graph 1)** Bus-based transit systems have the advantages of lower investment and operational costs. They are more liable to receive private investment and to be operated privately. Bus systems are more labor intensive, an advantage in developing countries. It is easier to partially or totally build bus systems than train

² Peñalosa, Enrique. Rethinking Third World Cities Transport. UITP 55th Conference, Madrid May 2003.

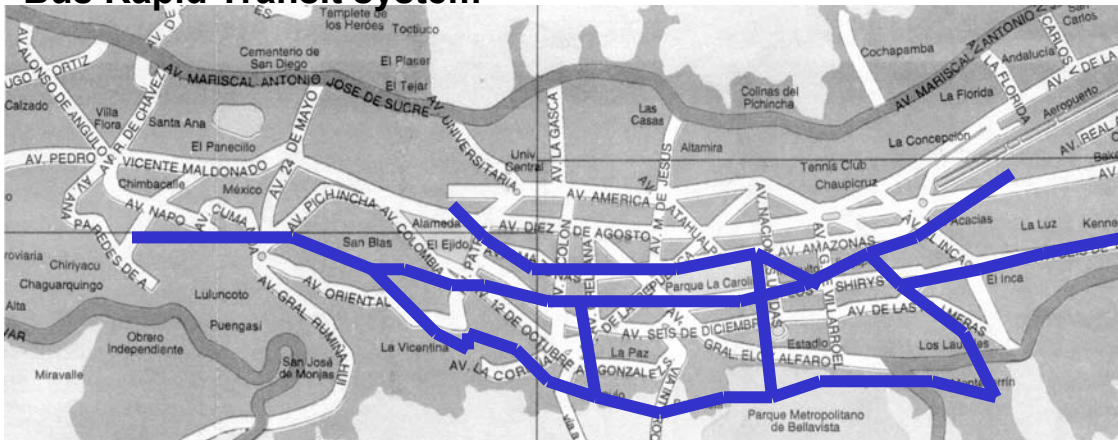
systems in developing countries. Finally bus systems are more flexible, an important asset in developing countries dynamic cities. As city attractions shift, it is easier to adjust a bus system than a rail one.

GRAPH 1. Panama City map comparing a Rail System and a BRT System with same resources³

Rail system



Bus Rapid Transit system



³ Prepared by Lloyd Wright for the Institute for Transportation and Development Policy

With the money that Bogotá would pay in one year of interest for a loan to build the metro, Mayor Peñalosa built 155 miles of bicycle paths that currently move 5% of the population. In January 1998, only 0.5% of Bogotanos used the bicycle as a means of transportation.

The Washington Metro cost about US\$ 11 billion for 166 kilometers and currently moves 824,000 passengers in a weekday. Comparatively, the cost for the Metro is more than \$ 66 million per kilometer and moves almost the same number of people that TransMilenio moves over 41 kilometers at \$ 5 million per kilometer. Not including the operational costs (the difference is enormous between the two systems), it is clear that in a developing city like Bogotá, with so many other needs for the poor, a different solution needed to be taken.

On the other hand, a busway like the one we had in Caracas Avenue was not the solution either. A new system – efficient, affordable, and comprehensive – needed to be created. That is what makes TransMilenio a successful project. It has *all* the characteristics that

describe a potential BRT system. All of them in conjunction make possible an urban renewal. Some often overlooked aspects include the improvements in public spaces and sidewalks, which serve the system by making it safer and acting as feeders.

One of the first decisions that Peñalosa took was to stop the busway that was going to be built in Calle 80 and change the terms of the World Bank loan to build an exclusive bus corridor. The old busway did not have good public pedestrian access, no pre-paid tickets, no stations. It was only two lanes in each direction reserved for the use of buses, which did not have schedules. *I want to emphasize this point: sometimes a BRT system is thought to be just exclusive lanes for buses ignoring the other key components, which result in a bad quality system that does not function efficiently with the desired impacts.*

III.THE BRT SYSTEM IN BOGOTÁ: TRANSMILENIO

TransMilenio is a Bus Rapid Transit (BRT) integrated system that is high capacity and low cost. The TransMilenio system was designed and developed under the principle of respect:

- for life: by reducing fatalities due to traffic accidents and reducing harmful emissions;
- for users' and their time: by reducing travel time, on average by 50%;
- for diversity: by offering full accessibility to young, elderly and handicapped, poor, among others;
- for quality and consistency: by using advanced transit technologies and providing a world-class system city wide at all times; and
- for economy and efficiency: by creating a system affordable by users and the city that is also good business to private operators.

Two or four central lanes in main arteries are given exclusively to the system for buses to operate without any other traffic. Central lanes and *not* lanes next to sidewalks are used in order to avoid traffic often generated from driveway entrances, gas stations and minor road intersections. As passengers board the buses at stations, central lane use also allows having one station serve both bus directions, instead of having two at each side of the road. Articulated 165-passenger

high-platform buses stop at stations and open their doors simultaneously with station doors. Since passengers have already paid or have been charged through a contact-less card at the station entrance and the station and the bus floors are at the same level, a hundred passengers can come out and a hundred more board the bus in seconds. The bus corridors are fully accessible to the handicapped. Passengers reach the station either by an elevated pedestrian ramp or crossing the road supported by a traffic light.

Feeder buses in regular streets with shared traffic bring passengers to the trunk lanes to which they can transfer at no extra cost. One ticket permits one passenger to change from a local-stops bus that makes all stops, to an express one that only stops every 5 or 10 stations; passengers can also transfer from one line to another. Cost is the same regardless of trip length. As most lower-income citizens tend to live in the outskirts and make longer trips, they make more use of feeder buses and are subsidized by higher income citizens that make shorter trips.

The integrated system has 470 articulated buses operating in 41 Km with exclusive corridors with 61 stations, and 235 feeder buses in 309 Km mixed traffic local streets. In its second year of operations (2002), it transported 207 million paid passengers, with a maximum of 792,000 passengers per day and 35,000 passengers per hour per direction. The long term plan envisions a total of 388 Km of exclusive lanes, from which 40 Km are under construction to be in operation in 2003-2005.

TransMilenio is a non-subsidized system, wherein all operating costs are recovered through the fares collected. The TransMilenio ticket costs US\$ 0.36 and that price covers all costs, except road infrastructure and stations. It is considered evident that since the government pays for road infrastructure for private cars, it must pay for roads used for public transport as well.

TransMilenio is a public-private partnership. Private contractors work in concert with TransMilenio S.A., the local municipal agency. TransMilenio S.A. manages bidding processes and controls the system operation but receives only 4% of the system's income.

Private contractors who operate the buses share in the system's income per bus-kilometer. A separate private contractor is in charge of ticketing and money collection, while another private company is responsible for distributing the revenues to all contractors and the municipal agency. Efforts were made to include traditional bus operators into the new system. In order to participate in the bidding process to provide and operate buses, companies must include traditional bus operators with a significant ownership share. Also, before an articulated bus is put into service it must demonstrate that its owners have bought and scrapped 7 traditional buses.

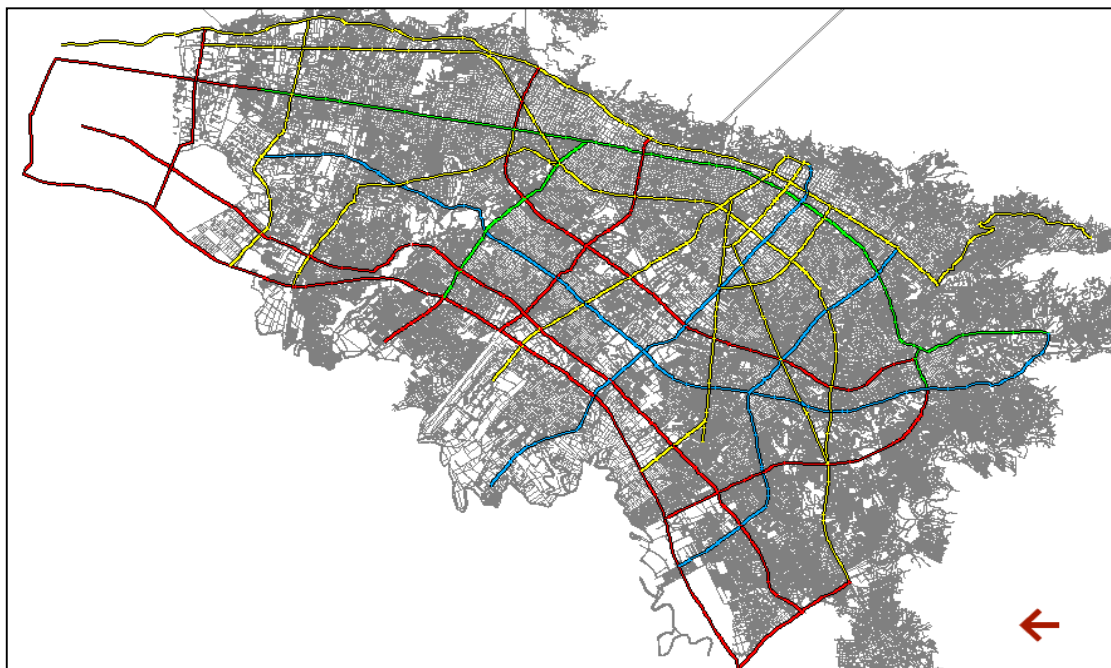
A local 25% tax on gasoline, of which 15% goes to TransMilenio infrastructure, support the system's further expansion. The National Government contributes funds as well (US\$1,250 million between 2000-2016) and it is promoting and now funding similar systems in other Colombian cities (Barranquilla, Bucaramanga, Cali, Medellín and Pereira).

An important effort was made for citizens to identify TransMilenio as a completely different, high-quality transport. Its name, the buses'

color, and the adjacent quality public space containing sidewalks, trees, lighting, and benches were carefully considered factors in order to make the system attractive to all socioeconomic levels. As it is much faster today to use TransMilenio than private cars, many car owners are leaving their cars at home and using TransMilenio. Currently 11% of TransMilenio users are car owners.

TransMilenio is programmed to continue expanding every year until 2,016 (**Graph 2**). By then more than 80% of Bogotá's 8.5 million citizens will live less than 500 meters away from a TransMilenio line. Bicycle parking stations will begin to be created soon near TransMilenio stations so as to facilitate that modal interchange.

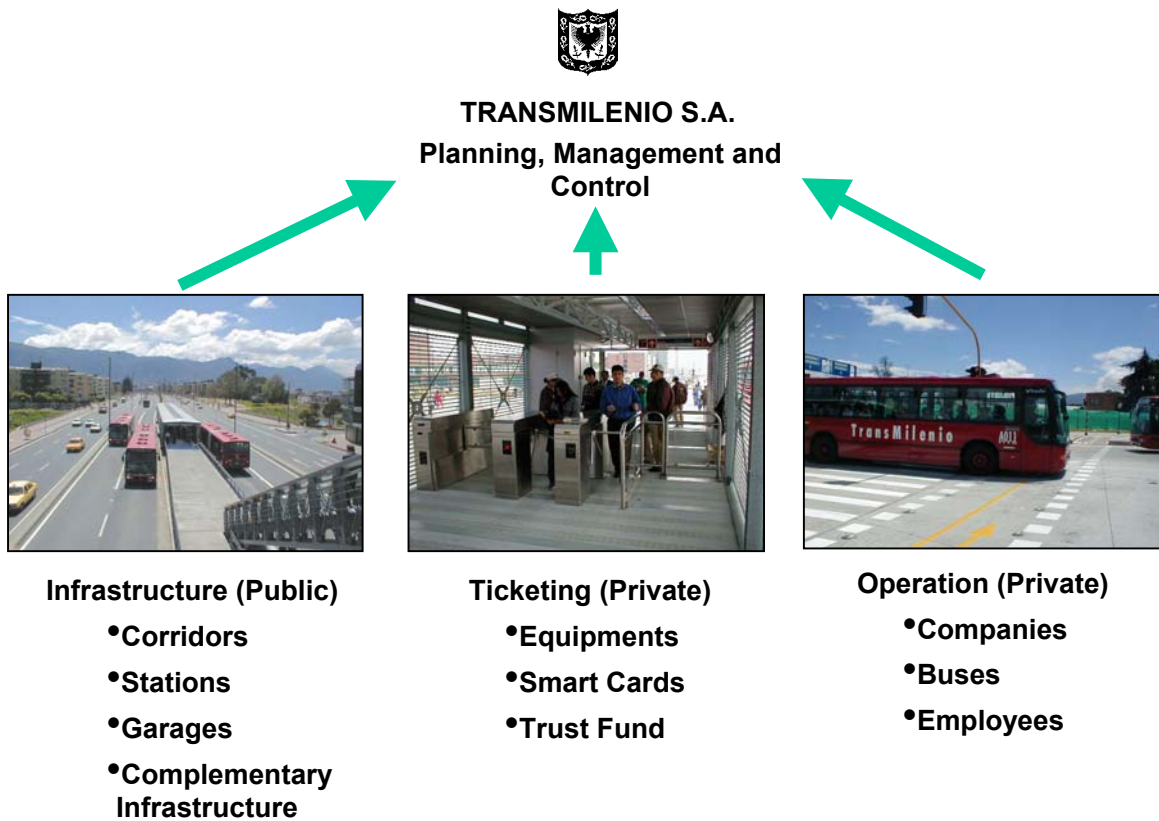
GRAPH 2. Projected Bus Corridors by 2016



IV. ORGANIZATIONAL STRUCTURE

Operations are contracted with private companies with conditions set forth in concession contracts for TransMilenio bus line services or operation contracts for feeder buses. (**Graph 3**). Private operators are consortiums of traditional local transportation companies, associated with national and international investors. Operators are selected through open bidding processes, and they are in charge of bus fleet acquisition, operation and maintenance, and hiring drivers, mechanics, staff, etc. They are paid as a function of the kilometers served by their buses.

GRAPH 3. System's Structure



A. THE PUBLIC ENTITY

TRANSMILENIO S.A., a public company created in October 1999, is the owner of the system. Its structure and staff are small -70 employees- given that it develops its charter through third parties, focusing its activity in planning the system and supervising the contracted activities. Its operation is mainly funded with 4% of the

fare revenues, as well as ancillary activities, like renting areas for commercial advertising and providing technical assistance services.⁴

The company operates a Control Center, equipped with 6 workstations, each able to control 80 articulated buses, which allows planning and real time supervision of bus operations. Each bus has a logic unit connected with a GPS, the odometer and the door opening system. The logic unit reports the location of the bus each 6 seconds with a 2 meter precision. The control operators have a monitoring screen for each service in schematic display and a digital map for physical location of the buses. The software is able to verify schedule compliance, giving the controllers the opportunity to make demand and supply adjustments in real time.

The construction of the corridors, stations and garages is done by the City's Institute for Urban Development (IDU). For the Phase I, the City built three bus corridors covering 41 Km, 4 terminal stations, 4 intermediate integration stations and 53 standard stations.

⁴ Hidalgo, Dario. TransMilenio: A High Capacity – Low Cost Bus Rapid Transit System developed for Bogotá, Colombia. UITP 55th Conference, Madrid May 2003.

Additionally, the city built 30 pedestrian overpasses, plazas and sidewalks.

Total investment was US\$213 million, funded with a local fuel surcharge (46%), general local revenues (mainly from a capital reduction from the partially privatized power company (28%), a loan from the World Bank (6%), and grants from the National Government (20%).

B. BUS OPERATION

The system operates with the correct number of buses to cover the demand with very efficient planning and centralized control. The system includes exclusive bus lanes (express and local) and feeder services. Express services only stop at designated stations. Local services stop at all the stations along their route. This combination allows for high capacity (buses use different stations to stop), better service to users (less stops) and better use of the bus fleet (more cycles per day). Feeder services attend to the periphery of the city, with full integration to the exclusive bus lane services.

Exclusive bus lane services use low platform articulated buses with a capacity of 160 passengers and advanced characteristics: pneumatic suspension, automatic transmission, and state-of-the-art buses (diesel or CNG). New or recent model buses are used in feeder lines, with a capacity up to 80 passengers each.

C. FARE COLLECTION

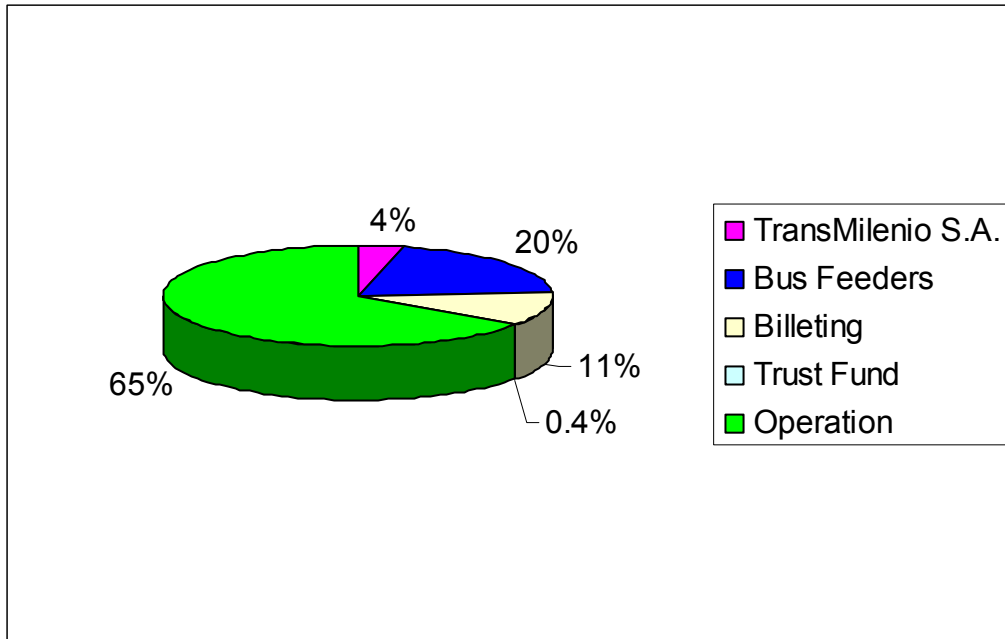
Fare collection is provided by a private concessionaire selected through an open bidding process. Money from fare collection is deposited daily in a trust fund, which is in charged of paying the system operators.⁵

TransMilenio uses a prepaid scheme. Passengers use contact-less electronic cards to access stations where they load the buses through multiple doors. The fare collection system includes producing and selling electronic cards, acquiring, installing and maintaining equipment for access control and validation, information processing, and money handling.

⁵ Hidalgo, Dario. TransMilenio: A High Capacity – Low Cost Bus Rapid Transit System developed for Bogotá, Colombia. UITP 55th Conference, Madrid May 2003.

The fare is US\$ 0.36 per trip (includes feeder service and any bus change) and totally covers capital investment, operation, maintenance and profit for the bus fleet and ticketing system operators. It also covers supervision and control of the system; administrative costs of the trust fund used to deposit the revenues; and the stations cleaning and maintenance. (**Graph 4**)

GRAPH 4. Revenue Distribution⁶



⁶ Information provided by TransMilenio S.A.

V. LESSONS FOR PHASE II

Phase II (**Graph 5**) includes three exclusive corridors that will add 40 more kilometers, 60 stations, including 3 terminals and 3 intermediate integration stations (2 exclusive busway connections and 1 feeder-exclusive busway), 335 new articulated buses through 3 operators. Expansions will be completed in the first quarter 2005, increasing daily passengers for the whole system to 1.5 million.

There are several enhancements in provided infrastructure from Phase I to Phase II, which can be summarized as follows⁷:

	Phase I	Phase II
Design Horizon	10 year	20 year
Type of contract	Mainly design-build using unitary costs	Build only at fixed total cost; includes financing for NQS and Suba corridors
Coverage	One-two busway lanes, two-four general traffic lanes per direction; not always including public space	One-two busway lanes, two-four general traffic lanes per direction; always including public space
Maintenance	Not included	5 year
Interchanges (bus and general traffic)	Three (simple)	Five (complex)
Interchanges (passengers)	None	Two including tunnels to connect stations
Pedestrian Overpasses and public space	27 (not always with public space provided)	39 (always with public space for ramps)
Land acquisition	300 properties (Calle 80) plus areas for terminals and depots (5 plots)	1200 properties

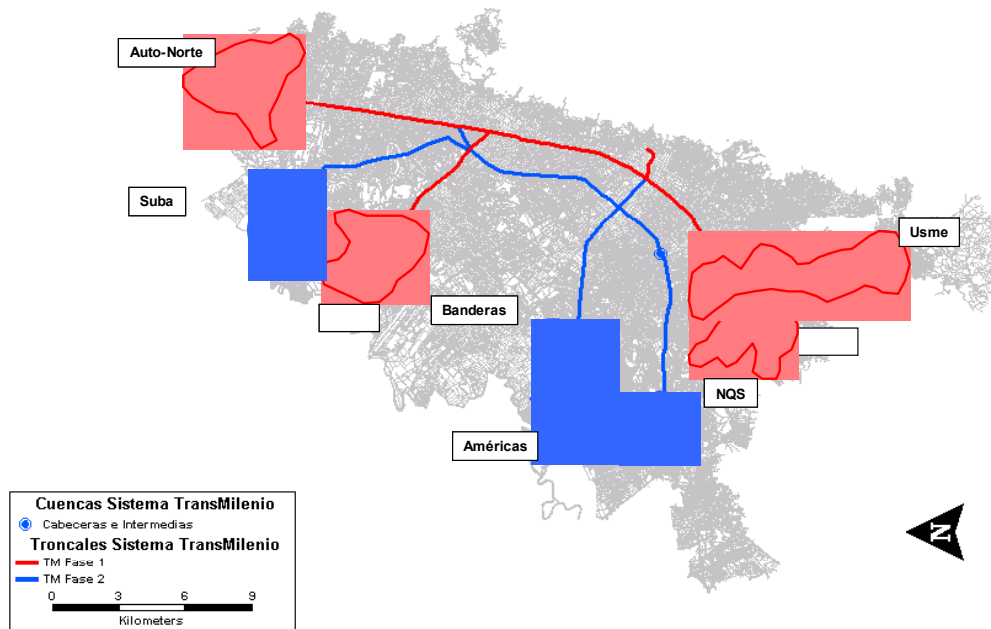
⁷ Information provided by TransMilenio S.A.

Due to experience gained in Phase I, the need to better distribute expenses and the desire to scrap more obsolete buses, some modifications to the first phase contracts were introduced:

- Responsibility for the cleaning and safety of the new stations were assigned to new operators.
- The local authority had more participation in the system revenues.
- Incentives were given to include owners of 1 or 2 buses as shareholders of the operator companies with a minimum of 10% of the shares (points were awarded to those that increase the offering, resulting in 21% of owners participating and close to 4,000 shareholders).
- Requirement to scrap at least 6 obsolete buses before introducing a new, articulated bus was mandated (points were awarded to those that increase the offering, resulting in a 7.1 average. In Phase I, only 2.7 buses had to be scrapped).

There were also some improvements in the bus typology, including weight sensors using the bus suspension, electronic boards inside the buses for user information, among others.

GRAPH 5. Bogotá map with TransMilenio Phase 1 and 2



VI. OPERATIONAL RESULTS

By May 2003 with 41 kilometers and 470 articulated buses and 235 feeder buses in operation, the demand was 792,000 passengers/weekday. Minimum frequency was 2 minutes (peak) and maximum frequency was 6 minutes (non-peak). In addition, there were 45 feeder services with a minimum frequency of 3 minutes (peak).⁸

⁸ Information provided by TransMilenio S.A.

TransMilenio's fare collection system has 90 selling booths, 359 turnstiles, and approximately 1,300,000 smart contact-less cards. Daily revenue is around \$ 270,000.

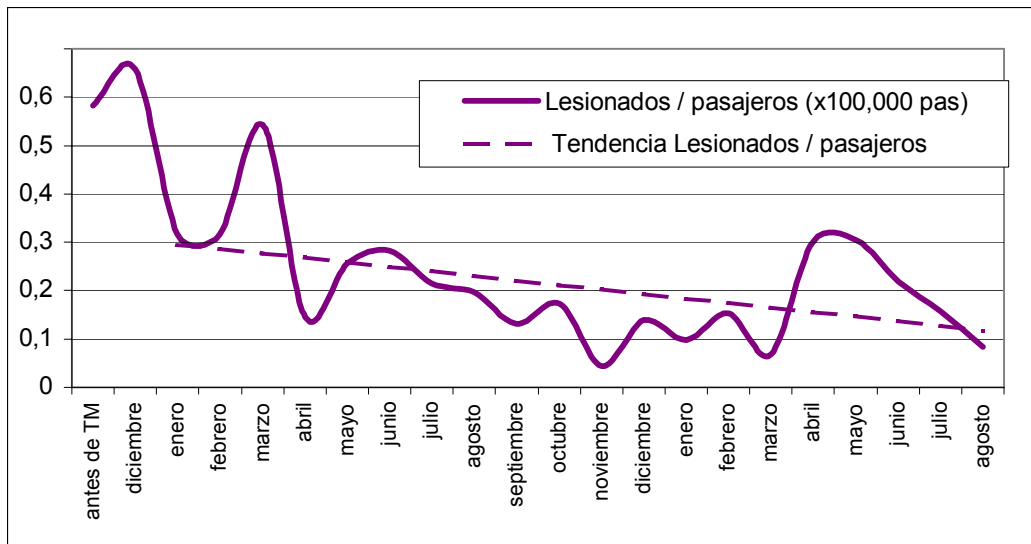
Commercial speeds of traditional public transit were 12 Km/h and 18 Km/h in Calle 80 and Avenida Caracas, respectively, before system implementation. These speeds increased to 26.7 Km/h in average for the different exclusive bus lane services.

One of the most important indicators is that 11 % of TransMilenio's riders are car owners.

VII. IMPACT ON CITIZENS' LIFE

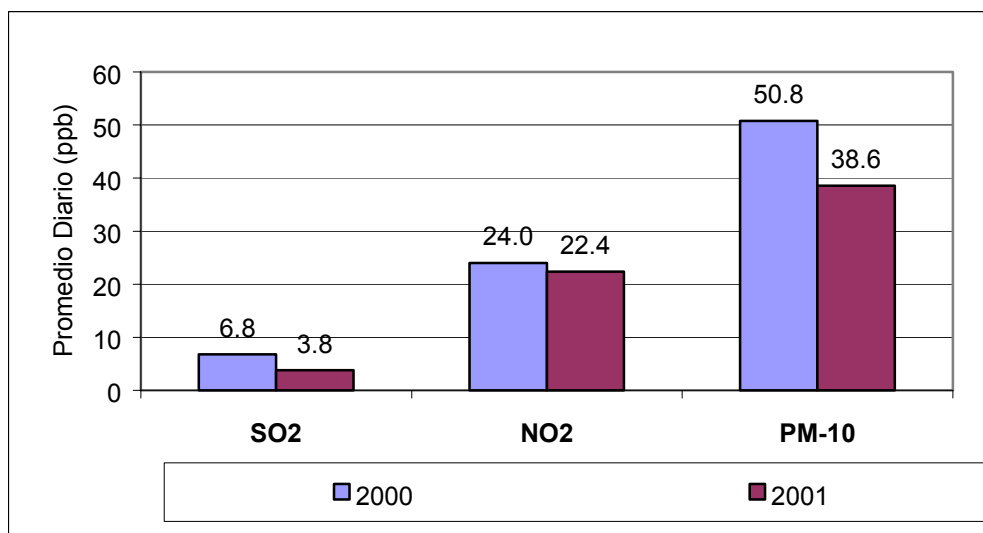
A comparison before and after TransMilenio indicates an important reduction in accident and air pollution levels. The decrease in injuries due to traffic accidents in the system corridors was 89% for fatalities and 83% for injuries. **(Graph 6)**

GRAPH 6. Traffic Accident Comparison⁹



There is an important reduction in the daily averages of some pollutant levels according to a monitoring station close to Caracas Avenue corridor. Noise has been reduced by 30% (**Graph 7**)

GRAPH 7. Air Quality Comparison¹⁰



The increase in speed allows a 32% reduction in average trip times for the users of the system. This has been reflected in user perception of the system: 83% of the persons answering a poll in March 2002 indicated that fast service was the main reason for using TransMilenio and that 37% spends more time with their family members. Most users of TransMilenio have gained more than 300 hours per year to themselves.

TransMilenio is fully accessible for users with disabilities, elderly, youngsters and pregnant women. About 1% of the users (7,500 persons per day) are among these categories of users. There are guides in the stations that provide information and support to all types of users.

The system has very high acceptance levels as a result of the very strict standards required to build the infrastructure and to operate the articulated and feeder buses. The satisfaction poll in April 2002

⁹ Information provided by Bogotá's Department of Transit and Traffic and Metropolitan Police Department.

¹⁰ Information provided by Bogotá's Department of Environment (DAMA).

showed that 78% of the respondents rate the system as being good or very good.

VIII. CONCLUSIONS

TransMilenio is part of a structural change to the transport systems in Bogotá. The first 30 months of operation demonstrate the great possibilities for this system to provide efficient and high quality mass transportation at a very low cost for the users and the government. It also shows that it is possible to introduce innovative private participation mechanisms, particularly from traditional private providers, under conditions that ensure sustainability and profitability of the service.

Project implementation was very fast. The project changed from a well-defined but general idea to commissioning in 36 months with Phase I being completed in a total of 48 months. This was possible thanks to a strong political will, adequate financial support for infrastructure development, and a lot of work from a committed and enthusiastic technical team.

A learning process has been applied in the system expansion: better infrastructure with innovative financing mechanisms; more participation of the city administration in the system revenues with a transfer of some responsibilities; inclusion of displaced bus owners; better environmental standards; new operators of bus lines and fare collection systems, among others. The system expansion shows that the provision of a high quality transit system at a low cost is a continuous process. The expansion is expected to continue, due to the high acceptance levels by the users and the population at large and its ability to provide reduction in travel time, accidents and pollution.

Mr. Chairman, from my own experience in Bogotá and with all respect I recommend the reauthorization of the Federal Transit program including the support of BRT systems in the United States and would like to finish my intervention telling that from beginning with an extremely negative self-image, Bogotá went to become a city with a sense of belonging and confidence in a better future thanks to the implementation of a different city model and particularly the TransMilenio. It comes from successful experiences elsewhere, an appraisal of our differences and aspirations and a realistic look at our

possibilities. Our proposed model is neither technologically sophisticated, nor economically demanding. It requires however political decisions aimed at truly making public good prevail.

Thank you again and I will be pleased to answer the questions you might have.

IX. ATTACHMENTS

A. ATTACHMENT 1. BOGOTÁ FACTS¹¹

Bogotá is the Capital and most important city in Colombia. It has 7 million inhabitants, 15,2% of the nations total. Population grows 2.5% annually and most of its people are young adults: 62% of the total are among 15 and 54 years old. The city is 8,500 feet above sea level, in the highest plateau of the Colombian Andes. The city covers an area of 32,000 ha and has a high density: 210 inhabitants per hectare. Most of its urban area is flat, with some informal development in the hilly areas in the southern part of the city.

The most relevant characteristics of transportation in Bogotá in 1988 were: Slowness (average trip was 1 hour and 10 minutes long); inefficiency (routes were 30 Km on average, with buses 14 years old on average and 45% mean occupancy rate); inequity (95% of available road space used by private vehicles moving 19% of motorized trips); contaminating (70% of particles released to the

¹¹ Hidalgo, Dario. TransMilenio: A High Capacity – Low Cost Bus Rapid Transit System developed for Bogotá, Colombia. UITP 55th Conference, Madrid May 2003.

atmosphere come from mobile sources; 1,200 deaths per year resulting from pneumonia associated with air pollution); and unsafe (52,764 reported accidents in 1998, resulting in 1,174 deaths).

To initiate a structural change in transportation conditions, Enrique Peñalosa's administration set forth an integral mobility strategy with actions to promote non-motorized transportation (recovery and construction of public pedestrian spaces, building a 300 Km bikeways network); reduce automobile use (city wide vehicle restriction using license plate numbers in peak periods, increase in parking prices, Car Free Days, among others), and development of a bus rapid transit system (TransMilenio).