CASE STUDY TRANSMILENIO, BOGOTÁ, COLOMBIA
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SUMMARY

TransMilenio is a bus based transit system featuring high end BRT features and integrated feeder services. The system is privately operated under concession contracts with a local authority expressly created to plan, supervise and control system components. TransMilenio is planned to expand gradually over several years. Two phases, covering 82 km of trunkways and six feeder areas, have been implemented between 1998 and 2006. The system serves 1.2 million passengers per day, and more than 40,000 passengers per hour per direction in the heaviest loaded section.

Things done well

- Successful planning and implementation in a very short time.
- The institutional arrangement provides an adequate distribution of responsibilities, incentives and risks in project development and operation: the public sector is in charge of the infrastructure, and planning, supervising and controlling operations, and the private sector is in charge of buses and fare collection acquisition and operation.
- Regulation and control are instrumented through binding contracts awarded after a competitive process. Priority to existing operators was given in the selection process.
- Private operators are totally funded with fare revenues - no operational subsidies required. The fare of USD 0.57 (as November, 2006) is similar to traditional services and allows for full integration within the system without extra payments.
- High performance: commercial speed of 29 km/hour; more than 1,200 pax per bus per day; and 5.3 boardings per km run. The service receives good ratings by the users.

Things that perhaps should have been done differently

- A few infrastructure details, such as some pavement structures and station floors, had early deterioration that could have been avoided with better design and construction.
- Implementation was rushed and several details had to be adjusted with the system under operation.
- Fare collection implementation could have longer time-table to complete operational trials and stronger supervision to avoid functional problems exhibited during the first months of operation.
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- Infrastructure for Phase II could have been designed and constructed at lesser cost, by reducing capacity for general traffic. Higher infrastructure costs in Phase II reduce the opportunities for further system expansion.
- Implementation of the new scheme of operations in May 2006 (completion of Phase II), could have been preceded by large scale user education campaign.
- Reorganization of routes and reduction of capacity in traditional system could have been better planned and enforced. Better coordination between city agencies was required.

Critical positive enablers

- Mayoral support, not only for initial planning and implementation, but also for system expansions in the following administrations.
- Conformation of a planning and implementation team outside the existing institutions and with enough capacity to develop system components.
- Retention of high quality consultants and dedication of time and effort to carefully design system components from the technical, financial, legal, regulatory and institutional perspectives.
- Existence of basic planning data from previous studies (technical cooperation, metro planning). It was not adequate enough but allowed for shorter planning times than starting from scratch.

Critical barriers

- Opposition from existing operators, especially bus owners, which feared loss of income. This barrier was overcome by giving priority to existing bus companies (and bus owners in Phase II) to be the concessionaries of the new scheme.
- Buses were considered unsuitable for very high demand transit corridors. Help from knowledgeable consultants allowed the definition of an operational design of express and local routes with a capacity not observed before in organized bus systems.
- Busways had very bad perception by the community at large. It was necessary to involve features to improve the urban space, develop a distinctive image, including media campaigns.
- Low fares in public transportation and difficulties to raise them. It was needed to design the system with the highest efficiency and even redefine components to match cost and revenues.
- Interference from non project participants within the government. This required the intervention and leadership of the Mayor.
CITY CONTEXT

Bogotá has 6.4 million inhabitants, 15.2% of Colombia’s total population. The city’s average population growth rate was 2.5% in 1999, which is considered moderate after average annual growth of 7% in the 1960’s. The city is located 2,640 meters (8,500 feet) above sea level and has an area of 1,732 km² (173,000 ha) with a very high population density (3,717 persons per Km²). Most of the urban area is flat, with some development in hilly areas in the southern part of the city. Bogotá is Colombia’s most important city and the administrative and political centre of the country. It has an autonomous government elected by popular vote.

Bogotá’s direct area of influence includes 21 Municipalities1 with a population of 900,000. The region can be regarded as a metropolitan area, but is not yet a conurbation with the exception of Soacha, in the south western limits of the city of Bogotá.

Most of the lowest income population is located in the periphery, especially in the southern and north-western parts of the city. Employment is located primarily in the extended CBD and in an industrial corridor extending to the west of the CBD.

Daily trips were estimated to be 10 million in 1995, 67% motorized and 48% using public transportation (JICA, 1996). Bogotá’s road network has 13,000 lane-km, 10,000 of which are paved. The road system is hierarchical, with many avenues and some short lengths of urban expressways. Traffic control is provided by a centralized signaling system serving 920 intersections. Capacity has been reached in many of the arterial intersections, causing significant delays. The planned arterial system is 60% of what was originally planned, and there is a lack of appropriate infrastructure in the periphery, especially in those areas that were developed without complying with the formal urban plan. Connections with the surrounding municipalities are concentrated in few roads.

More than 850,000 vehicles use the road infrastructure, with 21,000 of them registered as urban public transit vehicles that are privately operated. In 2000, 48% of public transit vehicles were mid sized buses (40-80 pax), 37% were small buses (20-40 pax), and 15% minibuses. There were different fares according to the service provided (normal, seated only, vehicle size), with an average fare of USD 0.35 (figure for year 1998). The fleet was considered obsolete and inadequate, with an average age of 14 years. In 2000, there were 629 authorized urban routes, with an average length of 49.2 Km, varying from 11.9 Km to 90.4 Km (SDG, 2000). The route coverage was high although there was also very high concentration on some arterial roads, especially in the CBD area.

1 Cajicá, Chia, Cogua, Gachancipá, Nemocón, Sopó, Tabio, Tocancipá, Zipaquirá; Bojacá, Cota, El Rosal, Facatativá, Funza, Madrid, Mosquera, Subachoque, Tenjo, Zipacón; Soacha and La Calera www.regionbogotacundinamarca.org.
The average commercial speed was around 17 Km/h, with some sections below 5 Km/h (SDG, 2000).

Urban routes were provided by 64 different private companies, which are actually loose affiliations of several small vehicle owners. These owners derive their income from daily rent of the bus to drivers, which in turn derive their revenues directly from passengers. Each bus is then operated as an independent economic unit. As a result, there is intense competition between conventional buses for every passenger, even between buses affiliated to the same company. Moreover, traditional public transport routes have been assigned through permits that do not reflect supply and demand studies and there have not been enough institutional capacity to adequately control the conditions of such permits.

These incentives have resulted in fleet oversupply, low quality services and high social costs due to slow travel, high pollution, high accidents rates, as well as revenue leakages due to disperse accounting (i.e. all the moneys that exceed expected income for the bus owner are retained by the driver) Productivity in the conventional system was, and still is, low --less than 2.4 average passenger boardings per kilometer (SDG, 2000).

In 1998, the local government under Mayor Enrique Peñalosa (1998-2000) initiated a Mobility Strategy based on sustainable transport principles. The mobility strategy gave priority to public transit and alternative transport modes, while aiming to reduce automobile use. The strategy included: construction of bikeways and pedestrian facilities; implementation of a bus rapid transit system (TransMilenio); traffic management improvements; and road construction and maintenance. Additionally, the strategy involved activities to change habits and attitudes of the people. The most important of these activities include car use restrictions during peak hours for 40% of private vehicles, car free weekdays and a ballot consultation on policies toward car use.

The policies established under Mayor Peñalosa have continued under the following administrations: Antanas Mockus (2001-2003) and Luis Eduardo Garzón (2003-2007), despite the fact that they belong to different parties. Expansion of TransMilenio as well as construction of non-motorized facilities has continued with financial support from the National Government. The car restrictions implemented in 1998 have been maintained and enlarged.

DESCRIPTION OF THE PROJECT

TransMilenio started operations on 18 December 2000 with a short section of 14 km and has been significantly enlarged since. The system has full integration and high-end BRT characteristics. As November 2006 the system encompass 84 Km of median busways, 25% totally segregated (non-grade intersections), the remaining longitudinally segregated with at-grade signalized intersections; 895 large capacity articulated buses; 114 level access stations with prepayment,
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including six terminals, and four intermediate integration stations; 61 feeder routes with 420 line-km; 372 conventional feeder buses; very high service frequency, centralized control and a distinctive consumer image (Data from TRANSMILENIO S.A. reported in November 2006).

The system handles 1,260,000 pax/weekday (November, 2006), 48% of them using the feeder routes, and 6% from regional routes. Trunk operations, with articulated buses, exhibit very high performance standards: 40,000 pax/hour/direction in the heaviest loaded section; commercial speed 29 Km/h; 5.35 passengers per kilometer run; and 1,407 passengers per bus per day (Data from TRANSMILENIO S.A., November 2006). Public acceptance of the operation is above 70%, with the main complaints being crowding of the buses, and long waiting times for feeder services.

Operations are under private concession contracts with a city owned company in charge of planning, development and control of the system --TRANSMILENIO S.A. There are 5 private groups with 7 concessions for trunk operations and 6 concessions for feeder services and 1 concessionaire for the fare collection system. There is a trust fund than receives all the revenues and distributes them among the system agents, including TRANSMILENIO S.A., according to the concession contracts rules. Private investment (buses and support facilities, fare collection system) is estimated to be USD 210 Million so far.

The infrastructure of the system includes busways and general traffic lanes, stations, terminals, bus depots, non-grade intersections, pedestrian overheads, bikeways, sidewalks and local roads for feeder services. It has been built by the city through the Institute for Urban Development with local and national funds. Public investment has also included the centralized control center, which manages data and voice communications with trunk buses and supervisors. The cost of the infrastructure has been USD 785 million, 40% of it to support transit operations (busways, stations, terminals, depots), and the rest for general traffic, non-motorized transport, land acquisition and impact mitigation (environmental, social).

The main project milestones are summarized as follows:

- Election of Mayor Enrique Peñalosa October 1997. Mayor Peñalosa included the development of a bus system as a priority in his government plan, along with the implementation of a Metro system with national support.
- Early planning for system implementation started in January 1998. A planning team directly reporting to the Mayor was appointed to prepare the project and coordinate efforts of the different agencies. Previous studies include the Bogotá Master Plan (JICA, 1996) and the Integrated

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\[2\] IDU is an agency of the municipality, with autonomous budget and contracting ability that focuses in urban road construction and maintenance.
Mass Transport System Study (FONADE, Ingetec-Bechtel-Systra, 1997), mainly devoted to the feasibility of a metro line.

- City council approved the government plan 1998-2000 in March 1998, with the development of TransMilenio as a priority.
- Discussions with groups of interest (transport companies, financial sector) started in November 1998 and continued during the following year.
- Approval of the creation of TRANSMILENIO S.A. in February 1999. The company was incorporated in September 1999.
- Bidding for the first phase trunk concessions and fare collection system opened in October 1999. Concessions contracts were awarded in March 2000. Bidding for the first phase feeder services (4 year operation contracts) initiated in March 2000 and finished in July 2000.
- Construction of the first phase (41 km, three corridors) started in 1998 (Calle 80) and continued through 1999-2001.
- Operations were initiated on 18 December 2001 (three weeks free of charge, non peak service on 14 km of route, one terminal and 14 stations)
- Commercial service started 6 January 2001, with paper based tickets.
- Electronic fare cards were introduced March 2001 (mixed use with paper based tickets during 2 months).
- Expansion of first phase (42 km busways, 57 stations, 4 terminals) proceeded through 2001 up to June 2002. Main expansions were the opening of the south terminal (Usme) and north terminal (Autonorte) on 6 August 2001, and the second south terminal (Tunal) on February 2002 and a downtown leg (Museo del Oro and Las Aguas stations) in June 2002.
- Antanas Mockus was elected mayor in October 2000 and took office in January 2001. He included TransMilenio expansion in his government program (approved in April 2001).
- Planning for the second phase (42 km busways) began in 2000.
- Construction for the first trunkway of the second phase (Calle 13-Américas) was contracted in 2002 and completed in December 2003.
- Construction of the remaining trunk lines (NQS, Suba) began in June 2003 and was gradually completed on 2005 (February, NQS north section) and 2006 (April, NQS south section and Suba). Passenger services along these 29 km busway with 34 stations, started as transit infrastructure became available.
- With the completion of Phase II infrastructure, the operational scheme (trunk routes local and express services) was totally revised and became effective on 29 April 2006. The service plan was replaced with the introduction of a large number of express services, aiming to reduce user's travel time without significantly increasing the bus fleet. This
required the replacement of all system maps and re-education of commuters.

Details of the system are presented in the TransMilenio fact sheet. There is a long term plan to expand trunk ways to 388 Km to cover most of the public transport needs. In the short term there is commitment of the city administration to develop a third phase (21 Km). Planning for this expansion started in 2005 and it is expected to be in operation in 2008-2009.

ASSESSMENT

Planning

The project started as an initiative of Mayor Enrique Peñalosa to overcome the problems of the inadequate economic structure of public transport. One of the main problems faced by the local administration was bus-to-bus competition for the passengers, known as “Guerra del Centavo” (war for the penny). Even though there were some segregated facilities for buses (Avenida Caracas Busway, implemented in 1990-1991), the traditional scheme of operations by individual owners affiliated under transport companies not directly managing the operations, continued when the Av. Caracas Busway was introduced.

Moreover, an extension of the Av. Caracas Busway towards Calle 80 was contracted in 1997, as well as bays and pedestrian bridges in Autopista Norte, without touching the traditional structure of service provision. The main thrust of the TransMilenio project was to modify the structure of the incentives prevailing in public transport, with a long term vision but delivering short term results.

Funding, planning and implementation of transport projects was a priority for Mayor Peñalosa’s administration, and during 1998 a special purpose planning team directly reporting to the Mayor prepared and contracted transport, financial, and legal studies for project preparation, using a transport loan from the World Bank and local resources. International firms such as Steer Davies Gleave and McKinsey&Company, along with local consultants, participated in project preparation. Steer Davies Gleave retained knowledgeable Brazilian consultants as part of their team, with experience in Curitiba, Porto Alegre and São Paulo high capacity corridors. Coordination of this effort was the responsibility of Ignacio de Guzmán, a businessman with broad experience in the financial sector. He formed a small interdisciplinary group that worked with the consultants during the whole planning process, and coordinated actions of several city agencies (planning, public works, traffic, environment, utilities).
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<th>Barrier</th>
<th>Barrier Details</th>
<th>Solution/Mitigation</th>
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<tr>
<td>Buses were considered unsuitable for very high demand transit corridors</td>
<td>Av. Caracas had already 35,000 pax/hour/direction - a level of usage not observed in any organized bus system in the world</td>
<td>Participation of very knowledgeable consultants (Pedro Szasz, Paulo Custodio, Garrone Reck, and others), who were able to design an operational scheme that was able to handle very high demand levels</td>
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<td>Busways had very bad perception by the community at large</td>
<td>Av. Caracas busway –implemented in 1990-1991 without changing the business structure of traditional operators- resulted in urban deterioration, and very high accident and crime rates and pollution levels</td>
<td>Visits of the planning team and presentation to the media of the experiences in Quito, Curitiba and other Brazilian cities.</td>
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<td>Lack of adequate planning data</td>
<td>Origin-destination studies performed in 1995 under a technical cooperation study funded by the Japanese Government had several limitations and required large adjustments.</td>
<td>Intensive field data collection to adapt the available information to the project planning needs and participation of transport modeling experts (Luis Willumsen, Enrique Lillo).</td>
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<td>Low fares in public transportation</td>
<td>There was little room to fund project components and no opportunity to increase fares due to economic conditions of the target population</td>
<td>Introduction of very high efficiencies in system design and redefinition of system components in order to meet the financial goal of self-sustainability at existing public transport fares</td>
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<td>Lack of technical knowledge or experience of city planners</td>
<td>Project team required training and hands-on experience; potential delays in decision making and implementation</td>
<td>Technical visits to existing bus systems and working along experienced professionals (consultants)</td>
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<td>Lack of adequate institutions to develop the system</td>
<td>Directors and staff of existing institutions did not have the capacity to develop such a project due to day-to-day workload</td>
<td>The planning team was formed outside the existing institutions and reported directly to the Mayor – this team later was formalized as a new city agency TRANSMILENIO S.A.</td>
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<td>Interference from non project participants within the government</td>
<td>Directors of public agencies could interfere in project implementation by not providing timely authorizations or generating difficulties for project implementation (e.g. new permits to traditional transport companies)</td>
<td>The Mayor demonstrated his commitment to the project and his willingness to exercise his authority to remove roadblocks (for example, three Secretaries of Traffic and Transport that did not cooperate with the project were replaced over a 3-year period).</td>
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<td>Opposition from transport industry leaders and most transport companies</td>
<td>Traditional transport companies and their leadership (“sindicatos”) feared loss of business</td>
<td>Direct conversations with each head of the transport companies, open discussions of the terms and conditions before the bidding process, and significant preferences in the bidding process to existing operators.</td>
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Planning efforts had to overcome several barriers, which are described in the following table along with solution or mitigation measures adopted. Probably the most important barrier was overcoming opposition from existing operators who feared loss of business. Opportunities for participation were provided and some of the managers seized them, while others still opposed project implementation.

The Mayor’s commitment and the creation of a capable planning team (coordination staff and consultants) were the most important drivers for fast and effective implementation of the project (Ardila, 2004). Sufficient resources and priority were assigned for planning and construction and adequate coordination mechanisms were created. An emphasis was placed on project implementation which resulted in rapid progress but also meant that some issues (although relatively minor) were not resolved until the project was already under operation.

Finally, public participation in planning was scarce. The project was extensively discussed in the city council, but no special public consultation process was in place. There were, however, large efforts in public outreach and education in the later stages, mostly for informative purposes and user education.

**Decision process**

The project was a central part of Enrique Peñalosa’s election platform, and became a mandate when he was elected Mayor in October 1997. It was presented to the city council as a key component of the government plan, and approved in early 1998 along with the implementation of the first metro line with national government support.

Two additional approvals were required by the city council: the assignment of gasoline tax funds for project funding and the creation of the city agency in charge of the system. Both approvals required a lot of political bargaining with council members. The leadership of the Mayor himself and work by the planning team and members of the cabinet were required. For the funding issue, the city council agreed to use half of the revenues from a gasoline surcharge of 20% of the fuel price at the gas station\(^3\) in funding mass transport (bus or rail). In the creation of the city agency, the city council required that bidding process gave priority to existing operators. The city council also created a fund to mitigate negative effects of system implementation to existing operators\(^4\).

The project coordinator was Ignacio de Guzman, a businessman with large experience in the financial sector. With full support from the Mayor, he provided

\(^3\) Gasoline surcharge was increased in 2002 to 25% of the fuel price at the gas station; 50% still goes to mass transit.

\(^4\) The fund was partially used in loans to existing operators (transport companies) to start up the new companies to operate the system, using a revolving scheme, as well as in the support of a team that facilitated the transition, relocating routes from the trunk corridors to other areas of the city in direct negotiation with the transport companies.
the leadership and coordination abilities required to manage several issues for rapid planning and implementation, as well as the bargaining abilities to deal with the transport companies’ managers. He was able to present the project as a new business opportunity and convinced some of them to participate in the new scheme. He was also flexible enough to change some components of the contracts and bidding requirements to facilitate project implementation. Mr. de Guzmán nominated a young and very motivated interdisciplinary team to interact with consultants and to move the project ahead (Ardila, 2004).

Some important decisions in the process were: whether a rail alternative should be pursued, which corridor, with which operators, how the system is planned and controlled, technical elements (infrastructure, buses, and operations), financial aspects (fare and remuneration to the operators), and fare collection system (technology, implementation). These decisions are commented on below.

**Rail Alternative**

The national government under president Ernesto Samper (1994-1998) was interested in supporting the city of Bogotá in the development of an integrated transport system, based on heavy rail (metro). The government passed a law (1996) to allow the National government to fund mass transit projects up to 70% of the debt (previously limited to 40%). It also contracted feasibility studies for a rail oriented system (Ingetec-Bechtel-Systra, 1997). There was not an agreement between the national and the local government (Antanas Mockus 1995-1997, Paul Bromberg 1997) as to whether rail was the preferred option; as a result, there was not a definitive commitment between the two levels of government.

The next mayor, Enrique Peñalosa (1998-2000), included the metro development in his government plan, conditioned on national funding and in parallel with the development of a bus based system. Two Nation-District agreements were signed (February, 1997 and June, 1997) with an initial commitment of funding from the national government to support a 29 km metro line and 11 bus corridors (USD 2,500 million plus financial costs). The agreements also included an action plan for project final preparation and bidding, and conditioned disbursements upon some specific conditions regarding project preparation.

The next national administration, Andrés Pastrana (1998-2002), included the Metro project in the government program, but final approval of funding was delayed. In April 2000, the national government announced to the local government that funding for the metro project was not possible due to fiscal limitations, but support for the bus system (already being developed) was likely. The Metro project was postponed indefinitely. Final approval of national grants for the bus system came in November 2000. Funding for the bus system was expanded in January 2003 by the next national administration (Alvaro Uribe, 2002-2006).\(^5\)

\(^5\) President Álvaro Uribe was reelected for a second term (2006-2010) in May 2006.
Corridor selection

Selection of the first corridors, Av. Caracas, Calle 80, Autopista Norte, came after the completion of a basic alternatives analysis including impact, ease of implementation and growth opportunities. The decision was taken directly by the Mayor in 1998. The city already had a busway operating on Av. Caracas with more then 35,000 pax per hour per direction in appalling operational conditions. Construction of an extension through Calle 80 (20,000 pax/hour) was underway, but without changing the operational and economic framework. Autopista Norte is the natural northern extension of Av. Caracas, with 12,000 passengers per hour. The three selected corridors connect the extended CBD with dense residential areas in the southern, northwestern and northern parts of the city, and are very visible to the general public. Implementation did not require much additional land acquisition (Calle 80 was already being widened and land acquisition was fairly advanced).

The corridors for Phase II, Calle 13-Av. Américas, Av. Norte-Quito-Sur NQS, and Av. Suba, were selected also using a high level alternatives analysis in 2001. Connection to the densest areas in the southwest and northwest of the city was the main criterion, as well as increase system capacity in the north south alignment as Av. Caracas was expected to reach capacity with the Suba and Southern connections. The Calle 13-Av. Américas corridor (20,000 pax/hour) already had physical designs prepared (minor upgrades were needed), and a large plot for the terminal and depot was already purchased (initially for the Metro southwest terminal and depot). NQS (15,000 pax/hour) is a major north-south corridor (fully separated in most of its length) 1 km apart from Av. Caracas and connecting dense areas in the south western end of the city, with potential extension to the neighboring Municipality of Soacha (population 300,000). Av. Suba (20,000 pax/hour) is the main connection to a north west expansion of the city that lies behind a wetland and a hill and has more than 500,000 inhabitants (middle and low income).

For Phase III a more detailed analysis of alternatives was performed in 2003-2004 using transport demand models and considering costs and impacts, especially on the low income population. The analysis resulted in selecting a western leg (Av. 26, 15,000 pax/hour, connecting the CBD to the city airport) and a parallel corridor to Av Caracas (Carrera 10 and 7, with 25,000 pax/hour). These corridors are planned for implementation in 2008-2009.

Operators

The decision made was to choose the operators through an open bidding process, giving priority to existing operators. Additional requirements were a minimum capital commitment and international experience in large scale bus operations, which could be certified by including small share holding partners.
Bidding groups were formed by grouping existing urban transport companies, some of them bringing capital and managerial abilities from other industries.

The reaction of existing operators was, in general, negative, as they were not used to compete in bidding processes and to sign concession contracts. Traditional operators were used to receive permits through direct assignment by the transport authority, very often using political influence or corrupt practices. Companies also feared the risk involved in the large investments for bus acquisition (usually dispersed among many small investors/owners of each unit), and the political risk that government might fail in complying with its commitments (building infrastructure and retiring the existing operators of the corridor).

Some managers of the existing transport companies decided to participate, formed new organizations, discussed terms and conditions with the implementation team, and raised capital to comply with the minimum requirements. Most existing companies (59 out of 64) became shareholders of the bidding companies, but only a few of these companies controlled the newly created operators of the mass transit system. Participation of capital from other industries (bus-body builders, parcel transport, waste management) helped the creation of the new operators.

Opposition also came from owners of buses (calling themselves small owners), as they were going to be displaced and did not have opportunity to participate due to inability to provide capital. One coalition was very active in opposing the creation of TRANSMILENIO S.A. in the city council, and organized 7 large protests during 1999-2000 against system implementation (they stopped service provision and blocked some city arteries; however, these protests were always solved within 1-2 days). The fund created by the city council to help their participation was not very useful in the first phase implementation.

For the second phase, along with the requirement of experience as a local company, Mayor Antanas Mockus (2001-2003) requested the implementation of mitigation measures and giving points in the selection process for bidders bringing small owners as stockholders. Some associations of small owners, including the one that held the protests, participated in the bidding for Phase II.

Nevertheless, protests of small owners are still ongoing. In May 2006 they stopped transit service provision for two days, demanding to maintain the existing operations on the two new TransMilenio corridors (NQS and Suba) as well as the direct assignment of Phase III concessions, among other claims. It is important to mention that Mayor Luis Eduardo Garzón (2004-2007) pledged in his campaign a larger democratization of the property of the system operators (more than 30% of stock in hands of small owners of buses). This is one of the requirements for the bidding process for Phase III expected in 2007.
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Planning, control and supervision

System planning, control and supervision were assigned to a new autonomous agency. TRANSMILENIO S.A. was initially staffed with members of the implementation team. The first general manager was Edgar Sandoval, an economist with experience in public administration. He was general manager since the creation of the company in September 1999 until the end of the administration of Antanas Mockus (December 2003). He was in charge of implementation of Phase I (1999-2002) and preparation, bidding and initial operations of Phase II (2001-2003).

Control of the system is centralized, using automatic vehicle location and information and communications technology (voice, data). Operational planning is performed with advanced tools. The operation of the system is complex with many routes sharing the same infrastructure and feeder routes integrated at selected points. As the system grows, there have been several changes in operations, with major route reorganization in April 2006 when the NQS and Suba expansions were completed, that not only changed the service plan but also the coding and signing of the routes. Impacts of these reorganization are discussed below.

Planning, control and supervision of the traditional bus services remained under the Secretariat of Traffic and Transportation. Secretaries collaborated with system implementation, by eliminating or relocating traditional routes to other corridors, and controlling bus scrapping. These tasks had strong difficulties, especially for Phase II, when the traditional transport companies and bus owners staged protests and found ways to incorporate new fleet, reducing the impact of bus scrapping required to TransMilenio concessionaries.

The existence of an organized transit system (TransMilenio) and traditional non heavily regulated services, which are under different authorities, is problematic. The local administration, decided in September 2006, to consolidate transit services under a single authority integrating TransMilenio and the traditional services. This major challenge is expected to be prepared and implemented in 2007-2009.

Technical Aspects

Technical aspects were carefully planned to achieve the highest efficiencies possible. The retained consultants and the implementation team were very experienced in high capacity bus operations, and had knowledgeable support in financial and legal issues. The decision was to make a "world class" system. Investment in infrastructure was relatively high per km to provide adequate geometry and fully reconstructed busways, large enclosed stations and terminals, two lanes per direction (at least at stations), non-motorized facilities, safe access for pedestrians, and large bus depots, among other things.
In Phase II design standards were improved, after some problems with pavements and stations floors in Phase I (discussed below). Phase II infrastructure includes full corridor re-construction: grade separated intersections at critical points, expansion of road capacity for general traffic, complete treatment of sidewalks, and traffic and social mitigation measures, among other things. Extensive land acquisition was also required. Overall, the infrastructure constructed went well beyond the needs of the BRT and was in fact a full corridor transformation.

The most relevant questions raised in public discussions regarding technical issues were the type of buses (low floor/high floor) and propulsion technology (diesel/natural gas). The decision was to leave the selection of the final technologies to the operators, which used economic criteria and risk to select high floor buses and diesel engines (Euro II). Points were awarded in the selection process for cleaner technologies, and in the second phase one of the proponents offered Euro III. Diesel quality in Bogotá is poor (+1000 parts per million in sulfur content); it does not even meet Euro II standards. Natural gas has been promoted on environmental grounds; however, the existence of large subsidies for diesel and the lack of experience with natural gas in large scale bus operations have led to diesel being selected for bus propulsion.

Some technical details need improvement (see the following sections), but the key elements are in place to provide high capacity operations.

**Accessibility Aspects**

The system was designed to be wheelchair accessible for the trunk stations, terminals and buses. Standards set by the Colombian law for size and inclination of ramps were used, as well as the implementation of special turnstiles in every station and designated areas inside the buses with adequate restraints. The front doors of the buses and some blue color seats inside the bus were designated and properly marked for the elderly, handicapped and pregnant women. Front doors are assured to have better approximation to the platforms.

At the beginning the blue seats were located close to the driver, but they were difficult to access by the target groups. Blue seats were then relocated close to the front doors of the bus.

The accessibility measures were initially praised by groups of handicapped individuals. Nevertheless, the level of accessibility was not the same in the feeder buses, where only a fraction of the fleet was equipped with wheelchair elevators. A group of representatives of people with disabilities filed a law suit, and the State Council ruled in favor of the plaintiffs, ordering TRANSMILENIO S.A. to plan and implement accessibility measures in the feeder zones with participation of handicapped individuals.
Financial Aspects

System design was aimed to achieve a maximum operational cost (buses + operations + fare collection) of COP 800 (equivalent to USD 0.35 in 1999). This required revision of some aspects such as scope of the feeder services, fare collection and participation of TRANSMILENIO S.A. in the revenues. For financial analysis a relatively high rate of return was used, according to the prevalent economic conditions in 1999, and considering the fact that the project was considered highly risky. Also demand figures estimated with transport planning tools were adjusted downwards by 20% to cover estimation risks. There has been a discussion after Phase I was operating that the private operators were receiving excessive revenues. The following phases have been designed with a lower expected rate of return on private investment and a higher farebox revenue share for the local authority.

The fare is adjusted using a predefined formula built into the concession contracts. Currently (November 2006) it is COP 1,300 (equivalent to USD 0.57); it is 18% above the average fare of the traditional bus services. This differential has caused some users, especially low income passengers in zones not requiring transfers, to prefer traditional services. The fare for traditional services is set by the administration after consultation with transport companies.

Implementation approach

Bogotá launched the TransMilenio System as a first phase of an ambitious plan for 388 km of trunk ways. Phase II and Phase III planning started with the previous phase not fully implemented. Phase I showed the applicability of the new mechanisms to contract operations and to provide oversight, as well as demonstrating that very high capacity bus operations were possible. Additionally, each phase within itself had sub-stages with gradual implementation of sections and terminals.

Gradual implementation brings some advantages and some drawbacks. On the positive side, gradual opening gave the opportunity to the private operators and the government agency in charge of control to learn and adjust operational and infrastructure details. It also gave the opportunity to new users to adapt their travel patterns gradually as new commuters were integrated in relatively small steps.

However, when TransMilenio routes were restructured in April 2006 to incorporate the new NQS and Suba corridors, there was major confusion among passengers (and even the operators) which led to much criticism in the press and the public generally; most problems were largely resolved within one month (see section near the end of this paper).
With the gradual implementation approach, the incumbent operators of the corridors were also able to adapt as they were slowly shifted to other areas of the city. The opposition of companies and owners was also mitigated by the fact that the system was initially small compared to the rest of transit demand in the city. Phased implementation also allowed for improvements in the contracts and reduction of risk in the following phases.

On the down side, gradual implementation was operationally difficult, as terminals and depots were often not ready until later, generating some difficulties in providing adequate control points, return movements and parking. It was also complex in terms of traffic and transportation management during construction. Detours and temporary signs and traffic control personnel were required on a continuous basis for several months.

Probably the most important drawback of phased implementation is the fact that the city has to live with two very distinct systems at the same time. Commuters are required to stay in low quality services for a long time, as trunk line expansion is relatively slow (13 km per year). At the same time, phased implementation gives time to traditional operators to organize themselves to oppose system expansion. Some traditional operators have challenged the legal framework of the system, and also obtained support from political representatives for their own interests.

**Implementation Phase I**

The implementation of TransMilenio Phase I can be considered very fast. It went from a general idea to initial implementation in 35 months, and fully completed within a 4-year period. This was the result of a capable planning team oriented towards project implementation, with clear political will and full support from the political leadership.

Two processes were required for project implementation: construction of infrastructure and preparing and implementing operational components (buses, fare collection, control).

Construction of the infrastructure was contracted through the Institute of Urban Development (one of the two city agencies in charged of public works). The first phase was divided into different segments and a total of 34 contracts (supervision and civil works) were awarded and developed between 1999 and 2001; including modifications to those that were already underway since 1997 (Calle 80). Different contractors were assigned for sections of the busways, stations, terminals, and depots. This allowed for more participation of local construction firms, but created some problems in coordinating the activities of different contractors. In Phase II, fewer contracts for larger sections of the system’s infrastructure were awarded reducing the administrative burden.
With regard to operation concessions (buses and fare collection), preparation of the bidding documents required extensive consultations with interested parties (a fraction of the existing operators, equipment providers, financial and insurance sectors). This process took 6 months, between initial presentations of the proposed contracts until formally opening the bidding process. The formal bidding process for the trunk concessions took four months. There were four concessions offered, but only proposals were received for only three of them and it was necessary to reopen the bidding process for the fourth concession.

Feeder services were contracted afterwards, with separate competitive processes for 5 different areas. The requirements for feeder services were less strict than trunk services, bidders could offer existing or new buses, and they could be owned or leased. Contracts were short term (4 years).

Commissioning of the system was rushed. Most components were not ready on the day of commissioning (18th December, 2000), resulting in several problems. Nevertheless, the system was very well received by the users and the population at large. Most problems were solved as the system was expanded.

Some implementation problems in infrastructure, operations, fare collection, and user education issues are discussed in the following paragraphs.

Infrastructure

Only part of the infrastructure was ready in December 2000. The system started operations with 14 km and 14 stations (not all the stations in the stretch). Stations were added gradually as they became ready. The 41 km of the first phase were only fully completed in June 2002 (last section completed was a leg along Eje Ambiental in the historic district).

The main delays in infrastructure were in the construction of terminals and depots (Autonorte and Usme, August 2001; Tunal, January 2002). Expansion of the system was limited until these pieces of infrastructure were completed. The construction of ancillary infrastructure was also delayed, such as the sidewalks in Av. Caracas, south section, which were completed in 2002.

Operations

The planned operational design was not well suited to gradual implementation. The initial operational design was prepared for the system being fully implemented. It was also based on planning data, which are not accurate at a disaggregate level. As a result it was necessary to follow a trial and error process by providing services, collecting information on real passenger flows, and then planning express services according to the demand. Service plans were continuously adapted as the system was expanded. The main challenge
was the need to provide timely information on changes to the users (production of maps, location of guides).

The available bus fleet was small at the beginning of operations, and became larger as infrastructure construction progressed. Bus driver training was required and learning happened rapidly. The productivity of the system was high from the beginning and the rates of accidents and incidents low.

Fare Collection

There were several difficulties with the fare collection system concession. Fare collection includes the provision of equipment, communications, fare cards, personnel, and money handling, among other things. Requirements for the operators were high as was the perceived risk. The implementation time for the fare collection system was also very short. Only one proposal was received. The concessionaire was able to comply with the requirements set forth in the bidding process although it was not experienced in large scale fare collection systems and had to learn during the process. There were some delays in implementation as well as operational and quality of service problems that were solved during the first year of operation.

For the bidding of the second phase there was a decision to seek another provider, which posed some challenges for integration. It was necessary to negotiate terms and conditions with the existing concessionaire to allow for a second fare collector on the system. After the bidding process was complete (three proposals were received), a group with the participation of the First Phase concessionaire was awarded the contract. The participation of an experienced equipment and card supplier from Korea improved the quality of the fare collection components.

User education

There was a large effort to educate the general public and especially the potential users of the corridors. During construction, a campaign was launched in mass media to promote the improvements expected from the system and mitigate the effects during construction. The campaign was partially funded by a commercial bank –Bancolombia-- interested in associating its institutional image with the expected success of the mass transit system in Bogotá.6

There were also guides providing information to pedestrians and business owners on the corridor, as well as meetings with the residents of the corridors in schools and community houses. Additionally, there were several meetings with

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6 Bancolombia is the largest financial institution in the country, and had been also associated with the user education campaign of the Metro System in Medellin, Colombia. The Bank’s motto “because everything could be better”, was well associated with the expectations of the new mass transit system in Bogotá.
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professional and commercial associations, such as the engineers and architects associations, the chamber of commerce, the trade unions for industry and banking, and the editors and directors of the most relevant newspapers, radio and TV news programs. There were also exhibits in the main parks and at the city fair, to show and explain to the people what was coming.

The most important element in user education was launching the system with free access for three weeks, giving the opportunity to thousands of persons to experience the system first hand. Service was only provided in non-peak hours and more than a million passengers used the system during this time. A large group of guides was retained for system opening and later kept as part of the system to help in expansion and service changes.

Despite these large efforts user education remains a challenge. Several rules designed to ensure efficient system operation are continuously violated. Passenger distribution within the buses is uneven (people concentrate in the bus entrances); people concentrate at the station doors making difficult to alight; dedicated seats for the elderly, expectant mothers and the handicapped are not respected, feeder services are misused for free local trips; and personal security is an issue with pick pocketing being the main concern.

Issues during Operation Phase I

TransMilenio completed five years of operation in December 2005. Expected demand was surpassed in Phase I by 17%. The system had good ratings by the users (above 70% in November 2006), and performance was considered good: 5.35 boardings per kilometer in trunk operations, 6.5 boardings per kilometer in feeder buses. There are several issues that have been improved since the first years and others that still deserve attention. Issues during operations are divided into institutional, financial, infrastructure, bus operations, fare collection and user friendliness:

Institutional Issues

The system is privately operated with public planning, supervision and control. The private and public agents have different incentives: while the private agents mainly seek profits, the public agent seeks user satisfaction and system coverage. Contracts provide the balance among these interests, but are subject to interpretation, and sometimes bring difficulties. For example, the bus fleet or fare collection need to be increased as demand grows, but contract requirements are ambiguous about these issues and agreements need to be negotiated. The private operation-public supervision scheme is also subject to changes in priorities and management by the administration. Bogotá has not had large changes in this respect, despite the changes in government.
The main institutional difficulty in Bogotá has been the result of uncoordinated efforts by the Secretariat of Traffic and Transport and TRANSMILENIO S.A. The Secretariat is in charge of the regulating traditional public transportation and it has not been successful in effectively reducing the traditional bus fleet and reorganizing the remaining routes. Buses scrapped through the concessionaries of the TransMilenio system have been replaced by new units operating on the traditional system. While there has been some benefit from this (new units provide better service and have lower emissions than the old buses), there is large congestion and oversupply on non-TransMilenio corridors.

Financial Issues

Operations can be considered financially successful. Nevertheless there were problems in some of the feeder services and the public agent TRANSMILENIO S.A.:

Feeder services in Phase I were contracted for 4 years. There were fewer passengers than expected in some areas, and services were enlarged to bring more passengers. Nevertheless, costs were higher than revenues and some operators ran deficits. Moreover, loan conditions were very strict, requiring repayment of new buses in 4 years. Another problem was that payment to the operators was indexed in proportion to the increases in traditional transport fares, but fares were not raised in 2001-2002. As a result, contracts were adjusted to improve the financial conditions of the feeder services contractors, partially solving most of these issues; nevertheless, two of the contractors were not able to reduce costs and went bankrupt before the end of their contracts.

Long before the end of the feeder bus contracts, TRANSMILENIO S.A. initiated the bidding process for a second phase, this time for 10 year concessions and with better conditions to adjust supply to conditions in 6 areas of the city. Contracts were awarded in 2003 and started operations in 2004, replacing operations of the previous contracts (including early replacement of bankrupted operators in two areas).

Another agent with financial stress—i.e. not fully covering its costs from its participation in system revenues—is the public company TRANSMILENIO S.A. In system design, the public company was envisioned as a small supervisor relying heavily on information technology systems. During operations it has been necessary to introduce supervisors on terminals, integration stations and critical points to report and solve operational contingencies, manage circulation within the terminals, and supervise driver and bus conditions. It has also been necessary to maintain a group of guides, and to support the police in charge of the safety on the system. As a result the number of staff and contractors is larger than expected, as are expenditures on other needs (administrative staff, requirements in communications, software, hardware, closed circuit TV, maps and variable message signs, etc.).
These financial needs have been mitigated with alternative funding: advertisements on stations and terminals, organization of events, training and consulting services. Participation of TRANSMILENIO S.A. in the fare revenue has also changed from 3% at the beginning of Phase I contracts, and later raised to 4%. The revenue sharing for TRANSMILENIO S.A. was set in 5.3% for Phase II contracts, along with the assignment of some responsibilities (vigilance, cleaning) on Phase II stations to the trunk bus operators.

**Fare Collection**

Most difficulties in the fare collection system were solved during the first year of operation. The fare collection concessionaire replaced turnstiles at the entrance of the stations with bidirectional units, improved the quality of the farecards, and continuously developed the software to improve service provision and reliability. One important improvement was the elimination of fare validation upon exit, which caused operational problems and delays. The change in the validation process required a modification of all station entrances and re-education of users. The process was completed within a weekend with work around the clock.

Two things were lost in the process of changing fare validation: the opportunity of having the ability to differentiate prices based on trip length and O/D data. The first was not considered an issue, as the fare design provides for a progressive cross subsidy from short trips to long trips. The latter are usually paid by low income commuters living in the periphery, which are benefited from the flat fare structure. Regarding data, it was recognized that most of it was not used, and that it was possible to reconstruct good quality O/D information with periodic surveys.

One outstanding issue regarding fare collection is queuing time at stations, partially mitigated with the sale of multiple fare cards. Multiple fare cards are not massively used, as no discounts are offered to buyers of multiple trips and there is lack of liquidity of buyers to purchase them. There is also some distrust on the farecards as they were not reliable the first year of operations. One option to reduce queuing without increasing costs dramatically can be the installation of automatic dispensers outside the system stations.

**Infrastructure**

Corridors were positively transformed with the implementation of TransMilenio infrastructure. Nevertheless there were some early operational issues: rutting of asphalt in the busway of Calle 80; cracking of concrete in Autopista Norte (and later on Avenida Caracas) and early deterioration of station floors. Problems with asphalt on Calle 80 were expected but caused concern to the media and control organizations; some investigations with local universities resulted in
improvements of asphalt pavements with special additives. Some sections, especially at critical stations, were rehabilitated using these mixture and showed better performance. Nevertheless, asphalt pavements of the busways continuously require maintenance.

The concrete pavements used in other sections of the system had design and quality of materials problems and have shown isolated cracking since the first year of operation. There has been a big discussion about this issue; usage of non suitable materials for the support of concrete slabs along with poor drainage, seem to be the cause of most problems. Continuous maintenance of pavements has been required, causing problems for system operations and the general traffic, as well as public perception of the system.

Stations were designed with light weight floors using aluminum wedges. The combined effect of drainage holes, sparse support and heavy pedestrian traffic caused cracks, which became a safety hazard. This problem has been solved through the replacement of aluminum plates, with fewer holes, and the introduction of additional support (trusses). Different lightweight materials are also under investigation.

### Bus Operations

Bus operations during the first 5 years of operation were smooth, with only two major issues: high occupation and delays in feeder services. High occupation in the peak hours and long waiting times for feeder buses remained the mayor user and public image concerns. The system has reached 42,000 passengers per hour per direction on Av. Caracas, showing the potential of buses for high capacity applications.

To improve productivity and commercial speeds, the operational programming was changed in Phase II implementation, with the introduction of a large number of express services for the peak hours, many of them with very few stops. There were several problems during the implementation of these changes that caused dissatisfaction among users during the first weeks of operation (see following section).

Management of at-grade intersections is a continuous challenge. Traffic police are provided at critical intersections to facilitate bus operations (prevent blockage by crossing traffic).

### Safety and Security

A comparison between the conditions before and after system implementation shows large improvements in terms of accident rates and personal security in the corridors. Nevertheless, high occupation has generated a propitious environment for pickpockets, which has also become a major concern for system users. This
has been mitigated with presence of policemen at all stations (auxiliary police and professional), introduction of closed circuit TV and educational campaigns. Success has been limited due to structural conditions (unemployment, lenient legislation).

A more difficult issue has been terrorist attacks. The system has been subject of bombings, both on trunk buses and feeder buses. Easy evacuation of a system operating at grade has resulted in few injuries or dead. Despite the efforts from the national government to curb violence in the country, peace has not been achieved and the system is a relatively easy and highly visible target. Extra control has then been provided by the police, assigning personnel to search bags and carry on items. CCTV cameras have been also installed.

**Implementation of Phase II**

In April 2006, after completion of infrastructure in the new corridors Avenida Suba and NQS south, a major modification of services was introduced. This modification was designed to provide very fast services between most origin and destination pairs, while keeping frequency at reasonable levels. The route coding and system maps were completely changed. The new operational system required user education, maps and signage. The preparation proved to be insufficient when operations were launched.

Implementation of Phase II occurred under heavy protests by traditional bus operators (especially bus owners), which opposed relocation of their routes and reduction in bus fleet. Traditional transport services were not provided in protest on May 2 and 3, 2006, causing additional stress on the TransMilenio corridors. To make things worse, the number of farecards provided by the fare collection concessionaire was insufficient, and sale of multiple trip cards was halted. Each passenger was required to pay for a single trip increasing the queues.

Implementation of this new operational scheme was problematic, with very high accumulation of passengers in some stations, long waiting times and high bus occupation. The learning process for operators, the authority and passengers was slower than expected by the administration. Complaints were followed by some stoppages caused by system users, protesting against low quality service.

To mitigate problems, fast reprogramming was introduced using actual data rather than simulated demand, a large number of people from the city administration (especially TRANSMILENIO S.A.) were sent to the stations as guides to educate users and help operations. Buses from the Pereira system (not yet in operation) were loaned for three months until new buses were incorporated. The fare collection concessionaire was required to increase the number of fare cards.
There are several opportunities to improve service delivery. Some actions that have the potential to increase efficiency and service quality are:

- Base the system programming on minimum waiting times rather than minimum number of stops, and introduce redundancy (different services for the same O-D pairs). The current service design gives priority to on-board travel time through the minimization of stops, making services rather quick, once the passenger is able to board a vehicle. Nevertheless, the operation is very dependable on good frequency control. When frequencies are disturbed due to traffic conditions, lack of communications or non compliance by the operators, waiting times are extended and bunching becomes a problem. As there are usually only two route options for a given Origin-Destination pair (a express service and a local service), a passenger is bound to wait a lot, without having much opportunity to divert his travel through a different route. Probably having a redundant option (a different express service with more stops) would provide a better distribution of passengers among routes.

- Introduce operational modifications, such as shorter routes for a portion of the bus fleet in heavy load sections only. This will make operational planning more complex (already very complex under existing structure). It will also require clear identification of returns and some civil works. Short routes might increase transfers and need user education and clear signage.

- Continue the incorporation of additional buses, which is a limited option at existing fare level. There is also a limitation on station capacity with headways close or below 1 minute.

- Operate convoys of buses, taking advantage of existing station design that allows up to two buses at platforms simultaneously.

- Introduce larger buses (e.g. bi-articulated buses) but this might require changes at stations (25 m platforms).

- Provision of services without transfer combining feeder and trunk operations. This will require special design buses with doors on both sides, step-down stairs, and on board fare collection for the feeder portion of the trip.

**Coordination with other transport initiatives**

TransMilenio is the flexible component of the so called “integrated transport system” included in the long term city plans. Other components are urban rail (metro) and regional rail. Resources for rail components are not available at this time. Currently city policies call for integration of TransMilenio with the rest of the public transport system, which seems very difficult due to distinct incentives structures. One element that might help this process is extending the existing fare collection system to the traditional system.
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In terms of coordination with other modes, there are provisions for adequate integration of bicycles (bike parking in terminals) and pedestrian (sidewalks, plazas, pedestrian flyovers and tunnels). No park and ride facilities or integration with taxis has been provided. Taxis park close to some stations, but there are no special bays designated for them.

Up to 9% of TransMilenio users are reportedly choice riders with access to private automobile. Half of them report that they use the system as a result of peak hour car restrictions (40% of vehicles banned from circulation in peak periods using plate numbers).

RECOMMENDED IMPROVEMENTS

Although the key elements of TransMilenio are in place, various improvements are possible to provide better service. The most important improvements can be divided into short term and medium term.

Short term improvements include:

- Improvement of operational planning to provide a better match between supply and demand and reduce waiting times. This is already happening and will include expansion of the bus fleet; nevertheless there are several possibilities using short cycles and reducing the number of express services.
- Intensify user education and attention to user complaints. This includes more guides and maps in stations and better signage.
- Incorporation of additional fleet to reduce headways.
- Improvement in control activities to reduce bunching and congestion at station platforms.

Medium term improvements include:

- Continue the expansion of the system to new corridors and feeder areas to provide service to areas not currently served as well as network effects. This does not necessarily mean expanding system infrastructure; different type of services, with fare collection on board could be used to serve other areas of the city.
- Eliminate the dual management of the transport system under TransMilenio and the Secretariat of Traffic and Transport.
- Introduce cleaner technologies for buses, including natural gas, ultra low sulfur diesel and hybrids, as they become commercially feasible.
ACKNOWLEDGEMENTS

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INTERVIEWS IN BOGOTA

Angélica Castro – Gerente General; Raúl Roa – Director de Operaciones; Sandra Ángel – Directora de Planeación, TRANSMILENIO S.A. (2006)
Mauricio Arciniegas – Director de Operaciones SI99-SI02, Operador del Sistema (2006)

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<table>
<thead>
<tr>
<th>BOGOTA</th>
<th>Main Sources</th>
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<tbody>
<tr>
<td><strong>GENERAL CHARACTERISTICS</strong></td>
<td></td>
</tr>
<tr>
<td>Population</td>
<td>8,350,000</td>
</tr>
<tr>
<td>Location</td>
<td>2,640 meters (8,500 feet) above sea level</td>
</tr>
<tr>
<td>Area</td>
<td>1,958 Km²</td>
</tr>
<tr>
<td>Density</td>
<td>4264.55 persons per Km²</td>
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<tr>
<td><strong>GOVERNMENT</strong></td>
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<tr>
<td>Bogotá is the capital of Colombia and, as such, the administrative and political center of the country. The city is responsible for the provision of public services, the administration of its resources and the development of infrastructure. In addition, the city carries out functions delegated by the central government, such as the provision of health and education, services that are financed by a decreasing percentage of national government transfers. The government and administration of the city are headed by the City Council and the Mayor, elected through popular vote for a four year period (previously 3 years term), without immediate re-election.</td>
<td>16</td>
</tr>
<tr>
<td><strong>ECONOMY</strong></td>
<td></td>
</tr>
<tr>
<td>2005 country GNI/capita ($)</td>
<td>2,000</td>
</tr>
<tr>
<td><strong>INCOME DISTRIBUTION</strong></td>
<td></td>
</tr>
<tr>
<td>Most of the lowest income population is located in the periphery of the city, especially to the southern and north-western parts of the city. Employment is concentrated in the extended CBD and an industrial corridor extending to the west of the CBD.</td>
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</tr>
<tr>
<td><strong>TRANSPORTATION DEMAND AND CHARACTERISTICS BEFORE BRT IMPLEMENTATION</strong></td>
<td></td>
</tr>
<tr>
<td>Daily Total Trips</td>
<td>10,256,545</td>
</tr>
<tr>
<td>Motorized Trips</td>
<td>67%</td>
</tr>
<tr>
<td>Public Transit Trips</td>
<td>48%</td>
</tr>
<tr>
<td>Total Motor Vehicles</td>
<td>850,000</td>
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### BOGOTA

<table>
<thead>
<tr>
<th>Total public transit vehicles</th>
<th>21,000</th>
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<tbody>
<tr>
<td>Average Commercial Speed</td>
<td>17 km/h</td>
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#### General Public Transport characteristics Conventional System

Urban routes are provided by 64 different private companies, which are themselves actually loose affiliations of several small owners of the vehicles. These owners derive their income directly from passengers with each bus being operated as an independent economic unit. As a result there is intense competition between buses for every passenger, even between buses affiliated to the same company. Moreover, routes had been assigned through permits that did not reflect supply and demand studies and there were not enough public resources to adequately control the conditions of such permits.

These incentives result in an oversupply of buses, low quality services, high social costs due to slow travel, high pollution, high accidents rates, and revenue leakages to bus owners and bus companies due to disperse fare collection.
### TRANSMILENIO

<table>
<thead>
<tr>
<th>GENERAL DESCRIPTION/ TECHNICAL CHARACTERISTICS</th>
<th>M. S</th>
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<tbody>
<tr>
<td><strong>Running ways</strong></td>
<td></td>
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<tr>
<td>• Trunk services operate on a dedicated busway. There are essentially two types of segregated runningway – single carriageway (3.5 m wide) and dual carriageway (7 m wide).</td>
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</tr>
<tr>
<td>• The single carriageway usually has an additional passing lane provided at stations along the route</td>
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</tr>
<tr>
<td>• Trunk corridors are located in central lanes of existing arterial streets and highways; longitudinally segregated from the general traffic. A short section in downtown (1.5 Km) is a bus and pedestrian only facility (transit mall).</td>
<td></td>
</tr>
<tr>
<td>• 7 Busways: 84 km (Phase 1: 42.4 km with 39.7 km (94%) of segregation; Phase 2: 42 km, fully segregated). 48 km of single carriageway (3.5 m wide), with passing lane at stations and 33 km dual carriageway (7 m wide).</td>
<td></td>
</tr>
<tr>
<td>• Feeders: 509 line-km, 7 zones (Phase 1: 309 line-km; Phase 2: 200 line-km).</td>
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<table>
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<tr>
<th><strong>Stations</strong></th>
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<tr>
<td>• Different station types: portals, intermediate, standard stations.</td>
<td></td>
</tr>
<tr>
<td>• Portal stations (terminal and transfer stations) located at the end of each trunk corridor for entering the corridor and transfer from the feeder routes.</td>
<td></td>
</tr>
<tr>
<td>• 7 Portal stations (Phase 1: 4 portal stations; Phase 2: 3 portal stations)</td>
<td></td>
</tr>
<tr>
<td>• Intermediate stations located along trunk corridors. They allow passengers to quickly transfer between trunk routes and/or between trunk routes and feeder routes.</td>
<td></td>
</tr>
<tr>
<td>• 6 Intermediate stations (Phase 1: 4 intermediate stations; Phase 2: 2 intermediate stations)</td>
<td></td>
</tr>
<tr>
<td>• Standard stations with differences in the layout of their platforms. One type providing access for passengers to travel from one platform to the other. The other with two totally separate platforms.</td>
<td></td>
</tr>
<tr>
<td>• 103 Standard stations (Phase 1: 53 standard stations; Phase 2: 50 standard stations)</td>
<td></td>
</tr>
<tr>
<td>• Stations along the trunk corridor are located in the median approximately every 500 meters.</td>
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A Critical Look at Major Bus Improvements in Latin America and Asia: Case Study TransMilenio, Bogotá, Colombia

<table>
<thead>
<tr>
<th>TRANSMILENIO</th>
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<tbody>
<tr>
<td><strong>Stations</strong></td>
<td></td>
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<tr>
<td>• Stations have high-level platforms (same height as the floor of the buses, around 90-4 cms) for easy boarding.</td>
<td></td>
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<tr>
<td>• Pedestrian access is provided through overpasses, tunnels, or signalized intersections.</td>
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<tr>
<td>• 69 pedestrian overpasses (Phase 1: 30 pedestrian overpasses; Phase 2: 39 pedestrian overpasses)</td>
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<tr>
<td>• Stations have automatic doors coordinated with the buses for safety and efficiency reasons</td>
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<tr>
<td>• The stations are between 25 and 190 meters long, depending on the number of berths, and usually five meters wide.</td>
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<tr>
<td>• Walkways, plazas, and sidewalks are also constructed to supply pedestrian and bicycle access.</td>
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<tr>
<td>• Station capacity, enhanced by pre-board ticketing and multiple platforms, is estimated at 210 buses per hour per direction</td>
<td></td>
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<thead>
<tr>
<th>Operations/Service plan</th>
<th>15</th>
</tr>
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<tbody>
<tr>
<td>• TransMilenio service plans are dynamic and flexible with services liable to change over time to reflect changes in demand.</td>
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<tr>
<td>• To maximize service supply the system offers three basic types of service: local, express and super-express.</td>
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<tr>
<td>• Local services run all day from 5:30 a.m. to 11:00 p.m. and stop at all stations.</td>
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<tr>
<td>• Express services stop at 40 to 60 percent of stations.</td>
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<tr>
<td>• Super-express services stop at less than 20 percent of stations</td>
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<tr>
<td>• Two minute headway during peak periods for each service line, and a maximum off-peak headway of 10 minutes, depending on demand levels. The combined headways of multiple service lines are as low as 13 seconds at busy stations along the trunk corridors.</td>
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<thead>
<tr>
<th>Trunk Line Vehicles</th>
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<tbody>
<tr>
<td>• 805 articulated buses. (Phase 1: 470 red-colored Volvo and Mercedes articulated buses built in Brazil and assembled in Colombia; Phase 2: 335 articulated buses)</td>
<td></td>
</tr>
<tr>
<td>• The articulated buses are 19 meters long with a capacity of up to 160 passengers (48 seated).1,596 passengers per day on average.</td>
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A Critical Look at Major Bus Improvements in Latin America and Asia: Case Study TransMilenio, Bogotá, Colombia

<table>
<thead>
<tr>
<th>TRANSMILENIO</th>
<th>M. S</th>
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<tbody>
<tr>
<td><strong>The buses</strong> have high floors, automatic transmission, pneumatic suspension, and anti-lock brakes.</td>
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<tr>
<td><strong>Each bus</strong> has 4 large doors on the left hand side which are synchronized with the station doors, allowing an average dwell time of 25 seconds. All buses also have a right-hand side door with regular steps for access and egress in emergency situations or other times when the vehicle is not at platforms (i.e. garage).</td>
<td></td>
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<tr>
<td><strong>All buses</strong> are equipped for people with physical needs, with specific seats reserved for the handicapped, elderly, and pregnant.</td>
<td></td>
</tr>
<tr>
<td><strong>All buses</strong> run on diesel in compliance with Euro II emission standards.</td>
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<tr>
<td><strong>Daily kilometers per bus</strong> have been growing from 216 to 370 as a result of the system expansion, extended hours of service and a higher number of express services.</td>
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<tr>
<th>Feeder services Vehicles</th>
<th>M. S</th>
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<tbody>
<tr>
<td><strong>The standard green-colored feeder buses</strong> carry up to 80 passengers and comply with strict operational and environmental requirements. Feeder buses are assigned to routes in the outskirts of the urban area.</td>
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<tr>
<th>ITS</th>
<th>M. S</th>
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</thead>
<tbody>
<tr>
<td><strong>A Control Center</strong> equipped with 10 workstations (Phase 1: 6 workstations; Phase 2: 4 workstations).</td>
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<tr>
<td><strong>Each workstation</strong> is able to control 80 articulated buses and allows service and passenger access supervision. The system permits voice and data transfer between all articulated buses and system supervisors.</td>
<td></td>
</tr>
<tr>
<td><strong>Each articulated bus</strong> is equipped with a Global Positioning System, odometer, and door opening system and a processing unit that reports its location every 6 seconds with 2 meter precision.</td>
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</tr>
<tr>
<td><strong>Supply of buses and service demand</strong> are then coordinated, and contingencies managed in real time. Optimized timing of traffic signals at intersections along trunk corridors further reduces bus travel times.</td>
<td></td>
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</tbody>
</table>
| **Phase 2** featured some improvement in the bus specifications. These included the placement of weight sensors in the bus suspension to prevent overload, electronic boards inside the buses for real-time service information, and an electronic tachograph.
## A Critical Look at Major Bus Improvements in Latin America and Asia: Case Study TransMilenio, Bogotá, Colombia

### TRANSMILENIO

| Fare Collection | • Pre-paid contact-less smartcard technology.  
|                 | • Cards are charged at ticket booths in the entrances of the stations and areas of integration at portals. No card sales are provided outside the stations.  
|                 | • Cards are automatically debited at the turnstiles (off-board validation). |

### FARES

- Flat fare equivalent to 0.57 USD (November 2006), includes free transfers from and to feeder buses in portals and integration stations, and transfers between trunk buses.

### SYSTEM PERFORMANCE

| Speed | • Local services have an average speed of 21kph.  
|       | • Express services have an average speed of 35kph.  
|       | • Overall average public transit travel speeds has increased by approximately 18kph to 29 kph.  
|       | • Average commercial speed for Phase 1: 26 kph.  
|       | • Average commercial speed for Phase 2: 32 kph. |

### DEMAND

| Total Riders | • 1,260,000 pax/weekday (as November 2006). Expected: 1.4 million passengers per day (Phase 1: 790,000 pax/weekday; Phase 2: 610,000 pax/weekday –estimated) |
| Peak-Hour Riders | • Maximum passenger observed load: 45,000 pphpd.  
|                 | • Average load peak section: 40,000 pphpd.  
|                 | • However, theoretical system capacity for a 2+2 lane busway with five platforms (2-2-1) and express services (skipping stations) is estimated at 48,000. Higher capacity may be achieved through optimized signal prioritization, grade separated intersections, larger buses and/or additional platforms at stations. |
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**TRANSMILENIO**

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<tr>
<th>IMPLEMENTATION BENEFITS AND IMPACTS</th>
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<tr>
<td>Estimated system-wide travel time saving of 136,750 hours per day for TransMilenio Phase I, equating to a 32 percent reduction in average travel times for transit users.</td>
</tr>
<tr>
<td>Time savings of around 16 minutes per trip to the individual transit user.</td>
</tr>
<tr>
<td>Overall reduced average travel time in the city by 13 minutes per trip.</td>
</tr>
<tr>
<td>Greater travel time savings for people in the lower income groups; 18 minutes for the lowest income stratum, compared to 10 minutes for the people in the highest income stratum.</td>
</tr>
<tr>
<td>TRANSMILENIO S.A. has a service quality system (ISO 9000 certified), which is responsible for user surveys, performance measurements, and complaints.</td>
</tr>
<tr>
<td>The system has reduced the number of collisions on the service corridors by 79 percent, which has in turn dramatically reduced the number of injuries and fatalities. Most of it due to the replacement of the previously unregulated system which featured aggressive and under-trained individual bus operators.</td>
</tr>
<tr>
<td>Increased transit usage (the sum of “Bus-Buseta-Colectivo” and “TransMilenio”) from 64 percent in 1999 to 70 percent in 2005. TransMilenio only accounts for around 27 percent of the city’s total transit trips.</td>
</tr>
<tr>
<td>Proportion of non-motorized trips has increased from around eight percent in 1999 to around 15 percent in 2005, while during the same period the proportion of private vehicle trips has reduced from 18 percent to 11 percent.</td>
</tr>
<tr>
<td>Survey data also suggest that TransMilenio has induced some shift to public transit. 9 percent of surveyed riders stated that before TransMilenio they made the same trip by private car.</td>
</tr>
<tr>
<td>TransMilenio implementation has reduced the number of robberies on system corridors. This may relate to the significant police presence in and around the stations.</td>
</tr>
<tr>
<td>Much higher bus productivity: while traditional buses carry less than 350 passengers on a typical weekday, the new trunk line buses serve more than 1600 passengers per day.</td>
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<tr>
<th>INSTITUTIONAL ARRANGEMENTS</th>
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<tbody>
<tr>
<td>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 thousand of small enterprises with many individual bus owners and operators.</td>
</tr>
<tr>
<td>A new transit authority, “TRANSMILENIO S.A.”, was established in October 1999, and given the...</td>
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</table>
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**TRANSMILENIO**

- responsibility of planning and managing the construction of the TransMilenio project, and overseeing its operation.
  - The project was planned, designed and constructed by both local and international companies.
  - Resistance to change from a fraction of traditional operators and small bus owners was overcome by giving priority to their participation in the new business structure. Some operators seized the opportunity and created new companies or joined with investors from other industries to operate the concessions.
  - In transparent bidding processes seven concessions were signed for the trunk line services of Phase 1 and 2, six concessions for the feeder bus services and two concessions for the fare collection services, including the provision of turnstiles and smart cards.

**COST AND FINANCE**

- Infrastructure: USD 785 Million (busways, stations, terminals, depots, pedestrian access; does not include other general traffic improvements, such as resurfacing of mixed traffic lanes, land acquisition, flyovers)
- Buses and Fare Collection Systems: USD 210 Million (estimated), totally funded with participation in fare revenues.
- Total cost: 11.8 million USD per km (Phase 1: 8 million USD per km; Phase 2: 15.4 million USD per km)
- Total infrastructure cost: 9.3 million USD per km (Phase 1: 5.8 million USD per km; Phase 2: 13.8 million USD per km infrastructure cost). Infrastructure totally funded with public budget.
- Funding from the National Government 66% (partially funded with multilateral bank loans –WB and CAF)
- Local funding 34% (mainly from gasoline surcharge and other funds, including capital reduction of the partially privatized power company, and a loan from the World Bank)
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Exhibit 1
Map of the TransMilenio System as November 2006

Source: [www.transmilenio.gov.co](http://www.transmilenio.gov.co), visited November 2006
Exhibit 2
Profile Avenida Caracas

Exhibit 3
Profile Calle 80

Photo: D. Hidalgo, May 2006

Photo: D. Hidalgo, May 2004
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Exhibit 4
Profile Eje Ambiental Avenida Jimenez (Historic District)

Photo: D.Hidalgo, May 2004

Exhibit 5
Profile Avenida Suba

Photo: D. Hidalgo, June 2006
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Exhibit 6
Profile NQS

Photo: D. Hidalgo, June 2006

Exhibit 7
Typical Station with Pedestrian Flyover (Calle 80)

Photo: D. Hidalgo, May 2004
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Case Study TransMilenio, Bogotá, Colombia

Exhibit 8
Typical Station (Avenida Caracas)

Source: D. Hidalgo, June 2006

Exhibit 9
Typical Terminal (Portal Suba)

Source: D. Hidalgo, June 2006
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Exhibit 10
Intermediate Feeder Station (Molinos)

Exhibit 11
Bicycle Deposit in a Terminal (Portal Américas)

Photo: D. Hidalgo, May 2004

Photo: D. Hidalgo, May 2004