GOOD PRACTICES IN CITY ENERGY EFFICIENCY

Bogota, Colombia – Bus Rapid Transit for Urban Transport

Project title	TransMilenio BRT in Bogota
Sector	Urban Transport
Type of project	Bus Rapid Transit (BRT)
City and country	Bogota, Colombia
City population	8.2 million (Bogota Metropolitan area)
Initial investment	Phase 1 - $240 million Phase 2 - $545 million Phase 3 - $1.3 billion
Annual % energy reduction	47%
Project status	Phase I - completed Dec 2000 Phase II- completed in 2006 Phase III - ongoing; due to be completed by 2015/16 Phase IV-VIII - Planned

Project Summary

The TransMilenio Bus Rapid Transit (BRT) system in the City of Bogota, Columbia, provides the city with an efficient and safe mass transit system that encourages high ridership. About 1.5 million passengers travel on the system every day with the completion of its first two phases. The operation of the BRT system through a combination of advanced Euro II and III technology buses and improved operational efficiencies has played a clear role in reducing congestion throughout the city. The residents and visitors of Bogota are thus enjoying reduced travel time, cleaner air, and reduced accidents. With the implementation of the system, there has been a 32% reduction in overall travel time, 40% reduction in emissions into the air because of scrapping of over 2100 old public service buses, 92% reduction in accident rates in the corridors where the TransMilenio system operates. Post-BRT Bogota has recorded significant fuel savings of 47% while increasing the throughput by 60%.

With the successful registration of the Phase II-VIII of its BRT system with UNFCCC in 2006[1], the city expects US$ 25 million CDM carbon credits by 2012. Successful elements of the program include: strong leadership on the part of the City Mayor, careful design and planning, use of state of the art technology, establishment of a well-managed company, sound investment in infrastructure, and an efficient single fare pricing system.

[1] United Nations Framework Convention for Climate Change (UNFCCC). http://cdm.unfccc.int/Projects/DB/DNV-CUK1159192623.07/view

1. Introduction

Bogota, the capital city of Colombia, is located near the geographic center of Colombia, 2,640 meters (8,661 ft) above sea level. It is the largest and most populous city in the nation, with an estimated 8.2 million inhabitants in the metropolitan area in 2007 and a population density of 3,912 inhabitants per square kilometer. Its economy generates 25% of Colombia's total GDP.

The city's roads were highly congested with the significant growth in private car ownership and use. While private cars occupied 64% of the road space, they only represented 19% of the population, and the daily average commute time was 1 hour and 10 minutes each way. Other issues included high incidences of accidents and extremely high air pollution rates during peak travel hours.

By the end of the 1990s, Bogota's public bus transportation system suffered from underuse, with low quality service and efficiency. The average speed for public transportation was 10 km/hour and was reduced to 5 km/hour by traffic during peak hours. Passengers became increasingly frustrated by consistently long wait times for buses. To minimize waiting time, riders had to use the first bus available rather than wait for a less expensive bus to arrive. Without price regulations, private bus operators were free to hike up prices and charge far more than public bus operators. Other public transportation issues included high incidences of accidents and extremely high air pollution rates during peak travel hours. [2]

In 1998, Mayor Peñalosa launched a long-term urban mobility plan, as part of urban renewal strategy, consisting of a package of measures that would place restrictions on private automobiles, promote non-motorized transportation, and improve public transit by partly financing the infrastructure improvements. In 1999, after the new National Government rejected potential plans for a subway system, the Mayor of Bogota presented his plan for a Bus Rapid Transit (BRT) system, built upon the successful experience of Curitiba in Brazil. The transition to an effective BRT system would help realize the Mayor's four main goals by: (i) improving public transport system with respect to efficiency, safety, speed, convenience and comfort ensuring high ridership; (ii) restricting private automobile use; (iii) expanding and improving bicycle paths; and (iv) enhancing public space.

2. Project Description and Design

The original proposal of a public transit system that featured both heavy rail (Metro) and a network of buses was abandoned because it cost four times more than the proposed BRT system which required US$1-10 million/km to implement. The Mayor envisioned the BRT system as the centerpiece of an overarching integrated mobility strategy that required that the institutional problems that led to price hikes on the part of small private operators were adequately addressed. The small bus owners and drivers fought against the proposal by coordinating worker strikes in an effort to block its ratification.

[2] Lozano, 2003; Chaparro, 2002; Lieras, 2003. Adapted from, 'The Economics of TransMilenio: A Mass Transit of Bogota. CEDE. August 2004.

The Bogota BRT integrates the following four elements to ensure operational efficiencies of the BRT system:

Infrastructure: The system consists of 22 central trunk corridors, feeder zones, terminal stations, pedestrian overpasses, plazas and sidewalks. The establishment of dedicated bus lanes, including new bus stations and integration stations located at the end of dedicated bus lanes, ensures a smooth transfer to feeder lines. Traditional buses are banned from operating in trunk corridors.

Fare System: Ticket booths at the stations allow passengers to pre-pay for Smart Cards (fare cards) that use a magnetic device to streamline the boarding process and optimize ticketing. Passengers can change from a local to an express bus as well as one route to another using the same electronic fare card that is automatically debited at the turnstiles that are used to direct passengers. Revenues from card sales are deposited in a trust fund, from which the operators are paid according to the rules set forth in the concession contracts.

Bus Technology: The new buses use Euro II & III technology and operate on dedicated lanes 18 hours a day. The capacity of each bus is 160 persons with platform level access including room for disabled persons. Feeder buses are new and have a capacity of 70-90 persons. Trunk buses use the central lanes of existing streets, longitudinally segregated from the general traffic. The system is supplemented by feeder buses, which run on local streets.

Transit Management: The operational fleet center manages bus dispatch, informs passengers, produces reports, and maintains records. All buses are equipped with GPS (global positioning system) devices and are linked to the operation center. Under the centralized system of coordination, monitoring is done via eight substations (80 buses per station) and communication is established to schedule services and provide real-time responses to contingencies.

The BRT uses a variety of design features to accommodate high volumes of passengers. These include the use of high capacity buses, exclusive running ways, level boarding, off-board fare payment, and high service frequencies that permit headways as low as 13 seconds on busy sections of the system. Of the total eight phases in the TransMilenio BRT Masterplan for the construction of 388 km (241 miles); two phases have been completed. The second phase completed the construction of 84 km in 2006. The system is designed to transport 5 million people per day and divert 80% of city travel to the BRT system. Stations are located every 500 m with pedestrian access via overpasses, tunnels or signalized intersections.

The combination of express and local buses allows the system to carry up to 45,000 passengers per hour in each direction. The model has taken a multi-faceted approach by incorporating advanced technologies for ticketing and control and a sustainable private participation scheme. Both the transit management scheme and fare system went into operation prior to the start of the second phase of the project. The BRT system has been designed to be flexible and may be expanded over time to meet the needs of the growing city.

The municipality created Transmilenio S.A.[3], a public-private partnership (PPP), to plan, organize, and construct the transportation infrastructure, and oversee the operation of the system. TransMilenio (TM) is responsible for the construction of the BRT system's infrastructure. The corporation also manages concession contracts, awarded through an open bidding processes, with private firms, and a consortium for operations and ticketing. The consortium includes existing bus operators and runs both trunk and feeder buses. Four different firms, formed by the traditional bus service operators, won the contracts to provide service on the trunk corridors, and feeder buses are operated by three companies (Sidauto S.A., Codatermil, and Uribe & Uribe Consortium). Buses (including drivers) are contracted through private firms. TM oversees all finances and pays each operator according to each specific contract. The proceeds from the operations are deposited into the Trust Fund. BRT revenue is distributed as follows: (i) Trunkline Operators (65.5%); (ii) Feeder Service Operators (20%); Fare Collectors (11%); TransMilenio Company (3%); and Trust Fund Administrator (0.5%).

3. Cost, Financing, Benefits, and Effects

The TransMilenio is unique and represents one of the world's premier BRT systems. By leveraging much of the city's existing infrastructure, it demonstrates how cost-effectiveness could be leveraged in constructing and operating a public municipal transportation system. The stations were constructed to be low-cost and highly functional. The main investment has come in the form of the city's new rolling stock (buses.) The responsibility for the city's vehicle and fare collection costs was transferred to the private sector. The capital cost of the infrastructure for Phase I was US$297 million[4] or $ 9.4 million per mile ($ 5.4 million per km), exclusive of the cost of land acquisition. The cost for Phase II rose to US$545 million or $21.3 million per mile ($13.3 million per km). This higher cost of phase II was due primarily to increased investment in public space (bridges, interchanges, etc.) and associated transportation infrastructure improvements. TransMilenio's BRT Masterplan for 241 miles is estimated to cost US$3.3 billion.[5]

Phase I was financed through local fuel taxes (46%), national government grants (20%), a World Bank loan (6%) and other local funds (28%). Funding sources for Phase II were significantly different from Phase I, with funding coming from the national government (66%) and local fuel surcharges (34%). The local government mobilized resources by raising gasoline taxes, launching against tax evasion, increasing its property tax base, and reducing capital investments in the City's Telecommunication Company.

TM is designed to recover 100% of its costs through passenger fares. Given that it is privately operated, any increase in revenue from expanded ridership goes directly to the operators. Likewise, if costs increase while demand declines, the private operators are required to cover the risks and losses. The national and city governments only cover capital costs.

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[3] website: http://www.transmilenio.gov.co/WebSite/English_Default.aspx

[4] Clinton Climate Initiative, C-40 Cities: Bogota, Colombia. http://www.c40cities.org/bestpractices/transport/bogota_bus.jsp

[5] Applicability of Bogota's TransMilenio BRT System to the United States, (2006). Federal Transit Administration, USA.

Benefits

Financial & Fiscal Gains: The system improves upon Brazil's Curitiba system by operating without subsidies from public authorities. Fares were established at US$0.40 in 2000 and have been raised to US$0.61 in order to ensure that all costs of operations provided by private operators are covered. This was achieved through the successful implementation of a concession-based contract that aimed at regulating service operations and eliminating rents to avoid fare-hikes. The private operator can earn profits when demand for ridership increases and incurs cost in the case that the demand for ridership declines. The BRT provided the incentives for private operators to compete for specific route in terms of per-kilometer basis as opposed to a per-passenger basis. This has facilitated healthy competition "for the market" as opposed to an unhealthy competition "in the market" that characterized the former traditional system. This policy has enhanced operating efficiency, while reducing the fiscal risk imposed on Bogotá's city government. The reduction in operating costs has been significant; in 1999, the municipal budget's allocation for operating costs declined from 50 to 20 percent of its total budget.

Better Air Quality and Fuel Efficiency: TM appears to have improved air quality (40% reduction in emissions into the air) by transporting more passengers in less time and by employing the use of energy efficient vehicles and scrapping of over 2100 old public service buses. The following reductions have been reported: SO_2 decline by 43%; NO_x by 18%; and particulate matter by 12%. Bogota BRT has reported 47% fuel savings,[6] with the cumulative savings estimate for 7 years (2006-2012) of over 1 million tons of oil equivalent while increasing the throughput by 60%.[7] Estimated reductions of CO_2 equivalent emissions are estimated to be 15-25 million metric tons for the first 30 years of operation.

CDM Model: By earning the distinction of the World's first mass transport project registered with UNFCCC for the Clean Development Mechanism (CDM) in 2006, TransMilenio's BRT has become a model for similar transport-related CDM initiatives in the pipeline worldwide. The project is expected to earn US$25 million in carbon credits by 2012.

Faster Trips: Average trip times have been reduced by 32%; and TM users' travelling speed has increased from 12-18 km/hour to 26.7 km/hour. Reductions in traffic congestion have increased the speed of travel for other vehicles as well.

Better Safety: Fatalities have been reduced by 92%; injuries by 75%; and collisions by 79%. The number of incidents of robberies has also been reduced by 47%.

Increased Public Demand: At present, more than 1.5 million passengers use the TM system. The exponential growth in passengers using mass transit system since its operation in December 2000 testifies to the fact that the BRT is perceived as affordable

[6] Sylvia Klatka, Fuelling Bus Rapid Transit for Europe, April 2008, Transport Research Arena, Europe, 2008.
[7] CDM Executive Board.

and efficient. Once complete, the BRT system is projected to carry an estimated 5 million passengers, accounting for 80% of the city's total transport.

Efficient Regulation: Raising gasoline taxes mostly affects private vehicle owners who form less than 1/5th of the city's population. This resulted in the redistribution of resources in favor of the poorer city residents who constitute the majority of the city's public transportation users.

Bogota Before versus After TransMillenio

4. Lessons Learned

BRT projects are complex and require technical, financial, and legal studies to ensure successful implementation. Demand forecasting studies are very important and require a large amount of data and time to improve model calibration and determine an appropriate fleet size and required services. This underscores the importance of adequate funds for ex-ante project analyses. Mayor Penalosa mobilized a team to bring about municipal reforms for effective service delivery by promoting cost efficient schemes.

One of the greatest achievements of the TM system has been the successful implementation of a concession contract-based system for regulating service operations. The project encouraged the participation of small operators and provided them incentives to play an effective role in the public-private partnership for bus operations and fare collection with rights and responsibilities defined by the concession contracts. Previously, the bus owners and operators, often affiliated with trade unions and cooperatives, made profits by reducing or eliminating vehicle maintenance and by forcing bus drivers to work long hours. They did not have incentives to improve quality as they earned additional profits as demand increased. The overall policy framework has facilitated TM to oversee bidding, contracting and operations of the system and enforce checks and balances. The contract-system has demonstrated solid financial management because allowed bus operators to undertake the demand risk associated with running a public transit system.

Of course, implementation of the new TM system did have some unexpected and adverse effects on the city's existing public transportation system. Reductions in travel times accrued mainly to TM users, while the average travel times for the traditional public transportation systems actually increased by about 10%. Slow scrapping of buses from the traditional system appear to be also causing additional congestion in corridors not served by TM on (Lleras, 2003).

5. Project Innovation

Bogota's TransMilenio BRT system has used an innovative PPP approach that does not require subsidies for its operation. Under the PPP, the new public sector agency, TransMilenio S.A., plans the system, takes responsibility for funding its infrastructure, and supervises daily operations. Private sector participation has been promoted and the existing bus operators who have won competitive contracts are responsible for fare collection and operations (including vehicle costs). This PPP has been hailed as a great success for the BRT system in Bogota.

Through an innovative competitive bidding process that required bidders to have a certain minimum working capital, private bus operators were encouraged to form formal companies. Points were awarded to companies based on factors, such as experience, bus quality, and emission levels to encourage the operation of efficient and non-polluting vehicles. TM provided each bidder with equity to finance the replacement of a portion of its old fleet with new and efficient buses. Contracts require that private operators maintain their fleet and uphold high quality standards for service. In the case of non-compliance by an operator, his market share would be reduced.

6. Financial Sustainability, Transferability, and Scalability

The project has demonstrated solid financial management by promoting an innovative implementation strategy at the project design phase. In order for TransMilenio to be successful, it was imperative that fares should fully cover the cost of its operations. The project required that the fare should move up to US$0.40 in order to cover all costs of operations. Wary of the possibility for public resistance to a bus fare hike from US$0.30 to US$0.40, the city of Bogota approved the new rate a year before the TransMilenio BRT system opened. Following the rate hike, there was considerable public outcry not against the city itself, but against private bus operators. When TransMilenio opened a year later at a fare price of US$0.40, customers were already accustomed to the new price. Only a few who considered the fare increase as part of TransMilenio's planning process, protested. With higher quality offered, TM has continued attracting passengers from the traditional system and has encouraged a modal shift away from the use of private vehicles. Complementary policies like car restrictions have strengthened the demand for BRT ridership. The private sector earns 33% profit with obligation under the contract to maintain the quality of services provided. At the current fare of US$0.61, the rising number of passengers is a reflection that BRT is fulfilling public expectations. A recent survey reflects an 88% increase in customer satisfaction.

The TM project design is inherently flexible and could effectively scale up operations by adding more buses once the necessary infrastructure is in place. Buses are adaptable to traffic changes and demographic patterns and provide door-to-door service. However,

the Rail System (First Metro Line) is still part of the City Plan, but currently stands without any budget commitments. It is envisaged that the current capacity of 45,000 pphd will not be exhausted for decades once the system reaches its completion. Encouraged by the Bogota BRT's success, the Government of Colombia is now embarking on a major program to replicate similar systems in the Colombian cities of Medellín, Pereira, Bucaramanga, Barranquilla, and Cartegena.

References

1. Bogota BRT System
   http://www.c40cities.org/bestpractices/transport/bogota_bus.jsp
2. The Economics of Transmilenio: A Mass Transit System for Bogota (2004); Juan Carlos Echeverry, Anna Maria Ibanez, and Luis Carlos Hillon. CEDE
   http://www.banrep.gov.co/documentos/conferencias/medellin/2006/Laeconomiadeltransmilenio.pdf
3. Applicability of Bogotá's TransMilenio BRT System to the United States Final Report - May 2006 (Funded by the Federal Transit Administration)
   http://www.nbrti.org/docs/pdf/Bogota%20Report_Final%20Report_May%202006.pdf
4. Bogota: More Bikes and Buses, fewer cars
   http://sustainablecities.dk/en/city-projects/cases/bogota-more-bikes-and-buses-fewer-cars
5. Case Study on Mobilization of Private Capital in Bogotá, Colombia Submitted to
   Municipal Finance Task Force, RTI International
6. Bus Rapid Transport (BRT) – A Win-Win Solution for Mass Transit in Metro Manilla; Save the Air,Partnership for Clean Air, MMDA, March 4, 2005
7. New solutions for collective transport in cities: fuelling Bus Rapid Transit (BRT) for Europe. Sylwia Klatka, ConVoco Ltd; Strategic session: Challenges for Sustainable Mobility in Cities, 21-24 April 2008, TRA Europe 2008
8. Lleras, Germàn Camilio. *Bus Rapid Transit: Impacts on Travel Behavior in Bogota.* Master in City Planning, Department of Urban Studies and Planning, and Master of Science in Transportation, February 2003.
9. BRT Bogota, Colombia: TransMilenio Phase II-IV, PDD prepared by Gutter Consulting on TransMilenio, July 2004
10. TransMilenio Bus Rapid Transit System of Bogota, Colombia. Summary of Practice. Asia-Pacific Environmental Innovation Strategies (APEIS) Research on Innovative and Strategic Policy Options (RISPO) Good Practices Inventory
11. http:/www.citypopulation.de

ANNEX: CITY AND PROJECT PROFILE

CITY PROFILE

1. Name of the City	**Bogota**
2. Area	**Colombia**
3. Population	**7.8 million**
4. Population Growth Rate	**7185889 (2005); 6276428 (1999); In five years, Bogota pop grew by 14.5%**
5. GDP of the City	**US$386 billion**
6. GDP Growth Rate	**3.5%**
7. GDP per Capita	**US$8,900**

PROJECT PROFILE

1. Project Title	**TransMilenio BRT in Bogota**
2. Sector	**Urban Transport**
3. Project Type	**Bus Rapid Transit**
4. Total Project Capital Cost	**Phase 1 - $240 million** **Phase 2 - $545 million** **Phase 3 - $1.3 billion**
5. Energy/Cost Savings	**47%**
6. Internal Rate of Return	**N/A**
7. Project Start Date	**2000**
8. Project End Date	**2016**
9. % of Project Completed	**2 stages**

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