Public Transport and Sustainable Urbanism: Global Lessons

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Transit oriented development (TOD) is a viable model for transportation and land-use integration in many rapidly developing cities of the world, including those in Asia. TOD is a straightforward concept: concentrate a mix of moderately dense and pedestrian-friendly development around transit stations to promote transit riding, increased walk and bicycle travel, and other alternatives to the use of private cars. In a way, Asian cities have historically been transit oriented, featuring fine-grain mixes of land uses, plentiful pathways for pedestrians and cyclists, and ample transit services on major roads. However, the recent ascendancy in car ownership and rising incomes are unraveling the historical transit-supportive urban forms of many Asian cities, giving rising to an increasingly car-dependent built form. By focusing new construction and redevelopment in and around transit nodes, TOD is viewed as a promising tool for curbing sprawl and the car dependence it spawns. By channeling public investments into struggling inner-city settings, some hope TOD can breath new life and vitality into areas of need. And by creating more walkable, mixed-use neighborhoods with good transit connectivity, TOD is thought to appeal to the lifestyle preferences of a growing demographic, like childless couples, young professionals, and empty-nesters.

On the global stage, TOD is most fully developed in Europe, and in particular Scandinavia. Step-one in bringing TOD from theory to reality has been the formulation of a vision and conceptual image of the future metropolis, such as the celebrated "Finger Plan" of Copenhagen, Denmark and the "Planetary Cluster Plan" of Stockholm, Sweden. In both of these instances, corridors for channeling overspill growth from the urban centers were defined early in the planning process, and rail infrastructure was built, often in advance of demand, to steer growth along desired growth axes. As importantly, greenbelt wedges set aside as agricultural preserves, open space, and natural habitats were also designated and accordingly major infrastructure was directed away from these districts. The evolution of Copenhagen from a Finger Plan, to a directed rail-investment program along defined growth axes, to finger-like urbanization patterns is revealed by Figure 1.

Figure 1. Copenhagen's "Transit First" Spatial Evolution: From Finger Plan, to Five-Axis Radial Investment, to Corridors of Satellite, Rail-Served New Towns

The ability of inter-mixing land uses along linear corridors to produce an inter-mixing of bi-directional flows is an under-appreciated benefit of sub-regional land-use balancing. There is no better example of the efficiency and sustainability gains that come from balanced growth than Stockholm, Sweden. The last half-century of strategic regional planning has given rise to a regional settlement and commutation pattern that has substantially lowered car-dependency in middle-income suburbs. Stockholm planners have created jobs-housing balance along rail-served axial corridors. This in turn has produced directional-flow balances. During peak hours, 55 percent of commuters are typically traveling in one direction on trains and 45 percent are heading in the other direction. Stockholm's transit modal share is nearly twice that found in bigger rail-served European cities like Berlin and even higher than inner London's market share. Perhaps most impressive, Stockholm is one of the few places where automobility appears to be receding. Between 1980 and 1990, it was the only city in a sample of 37 global cities that registered a per capita decline in car use -- a drop off of 229 annual kilometers of travel per person.[1]

TOD in Asia: Singapore

A good model of TOD is Singapore, underscored by the island-state's Constellation Plan and development of compact, mixed-use new towns around many suburban MRT stations.

The city-state of Singapore is internationally renowned for its successful integration of transit and regional development, placing the urbanized island of 2.8 million inhabitants on a sustainable pathway, both economically and environmentally. As part of a national economic development strategy, Singapore has embraced Scandinavian planning principles that call for radial corridors that interconnect the central core with master-planned new towns. Its structure plan, called the Constellation Plan, reflects its namesake – from plan view, it has the appearance of a constellation of satellite "planets", or new towns, that orbit the central core, interspersed by protective greenbelts and interlaced by high-capacity, high-performance rail transit. Like Stockholm and Copenhagen, this rail-served settlement pattern has produced tremendous transportation benefits: low VKT per

capita (lower than any urbanized region worldwide with per capita GDRP over US$10,000) and high transit modal splits (480 annual transit trips per capita in 2002).

Singapore adopted the approach of building new towns that are not independent, self-contained units but rather nodes with specialized functions that interact with and depend upon other new towns. Some satellite centers are primarily industrial estates, some are predominantly dormitory communities, and most are mixed-use enclaves. Around three-quarters of residents of master-planned new towns work outside of their area of residence. Most, however, commute within the radial corridor that connects their new town to Singapore's Central Business District. This means travel is predominantly within, not between, rail-served corridors. Also, the dispersal of mixed land uses along corridors has created two-way travel flows and spread travel demand more evenly throughout the day.

Singapore is also noted for its progressive "transit first" policies that complement its transit-oriented Constellation Plan. The city has introduced a three-tier fiscal program that comes as close to "getting the prices right" within the urban transport sector as any city in the world. The first tier of charges is subscription fees for owning a car. Comprised of high registration fees, import duties for automobile purchases, and a licensing surcharge based on a quota system (indexed to congestion levels), these charges principally cover fixed costs associated with providing basic levels of road infrastructure and parking facilities. The second tier of charges are use-related, in the form of fuel taxes and parking fees, that cover incremental costs for scaling road capacity to traffic volumes and maintaining roadway infrastructure. The third set of charges – in the form of real-time electronic road pricing (ERP) – force motorists to internalize the externalities they impose in using their cars during peak hours. Fees fluctuate according to congestion levels, meaning motorists bear some of the costs they impose on others such as time delays and air pollution. Within a month of initiating electronic road pricing, traffic along a main thoroughfare fell by 15 percent and average rush-hours speeds rose from 36 to 58 kph. Vehicle quotas, congestion prices, and an assortment of fees and surtaxes (that add as much as 150 percent to a car's open market value) have reduced Singapore's annual vehicle population growth from 6 percent fifteen years ago to under 3 percent today, a remarkable achievement for a city where per capita incomes have risen faster over the past two decades than virtually anywhere in the world.

TOD in the United States

As the world's most car-dependent society, the United States might not be considered a model for examining TOD, however there are several positive experiences that are worth noting. Over 100 TOD projects currently exist in the United States, found overwhelmingly in and around heavy, light, and commuter rail stations.

No place in the United States has witnessed more high-rise, mixed-use development along a rail corridor over the past three decades than Arlington County, Virginia. Arlington County, Virginia is a textbook example of creating a vision (the "bull's eye" concept plan, shown in Figure 2) and putting in place appropriate implementation tools to achieve the vision. Through a collaborative effort that engaged local stakeholders and an

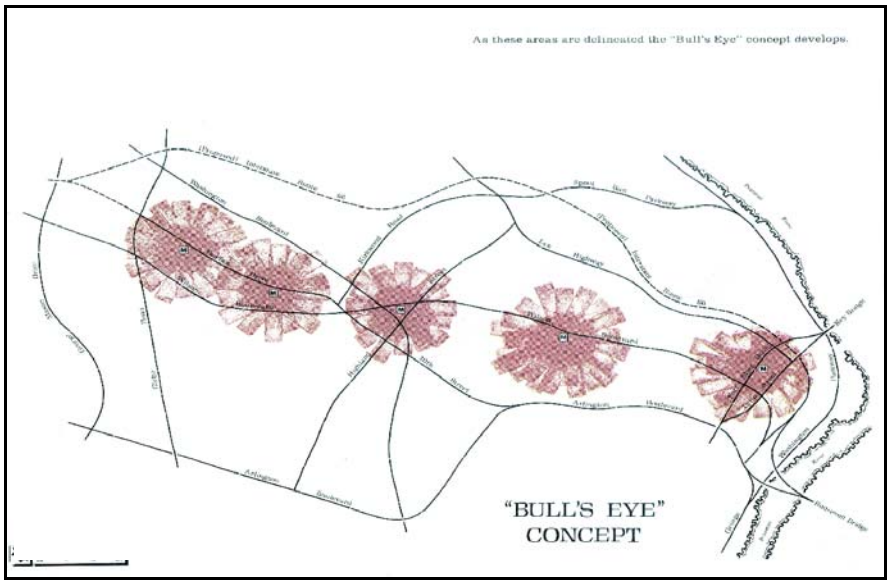


Figure 2. Arlington County, Virginia's "Bull's Eye" Vision for the Rosslyn-Ballston Corridor. *Source:* Arlington County Department of Community Planning, Housing and Development.

ambitious campaign that targeted supportive infrastructure improvements to rail stops along the corridor, Arlington County managed to transform the Metrorail Orange line into a showcase of transit-supportive development, with mid-to-high rise towers and multiple uses today flanking the Rosslyn, Courthouse, Clarendon, Virginia Square, and Ballston Metrorail stations. With the bull's eye methaphor in place to guide on-going planning (borrowing from the experiences of great "transit metropolises" like Copenhagen and Stockholm), Arlington County proceeded to leverage Metrorail's presence and transform once dormant neighborhoods into vibrant clusters of office, retail, and residential development.

In a recent national study, I probed the potential ridership benefits of TOD even in a car-dependent country like the United States. Arlington County's two major rail corridors – Rosslyn-Ballston and Jefferson Davis – have experienced a tremendous increase in building activity since Metrorail's 1978 opening: 24.4 million square feet of office space, 3.8 million square feet of retail space, some 24,000 mixed-income dwelling units, and over 6300 hotel rooms.[2] Of the nearly 190,000 people today living in Arlington County, 26 percent reside in Metrorail corridors even though these corridors comprise only 8 percent of county land area. If the development added to these two corridors had been built at suburban density standards, such as in neighboring Fairfax County, Virginia, seven times as much land area would have been required.

The addition of 35+ million square feet of new development along two rail-served radial axes was hardly the result of good fortune or happenstance. The transformation of once-rural Arlington County into a showcase of compact, mixed-use TOD has been the product of ambitious, laser-focused station-area planning and investment. Prior to Metrorail's arrival, Arlington County planners understood that high-performance transit provided an

unprecedented opportunity to shape future growth and proceeded to introduce various strategies — targeted infrastructure improvements, incentive zoning, development proffers, permissive and as-of-right zoning — to entice private investments around stations. After preparing countywide and station-area plans on desired land-use outcomes, density and setback configurations, and circulation systems, zoning classifications were changed and developments that complied with these classifications could proceed unencumbered. The ability of complying developers to create TODs "as-of-right" was particularly important for it meant developers could line up capital, secure loans, incur upfront costs, and phase-in construction without the fear of local government "changing its mind."

The pay-off of concentrated growth along rail corridors is revealed in Arlington County's transit ridership statistics. The County today boasts one of the highest percentages of transit usage in the Washington, D.C. region, with 39.3 percent of Metrorail corridor residents commuting to work by public transit.[3] This is twice the share of County residents who live outside of Metrorail corridors. Self-selection is evident in that around two-thirds of employed-residents in several apartments and condominium projects near Rosslyn and Ballston stations take transit to work.[4] An important outcome of promoting mixed-use development along rail corridors has been balanced jobs and housing growth which in turn has produced balanced two-way travel flows. Figure 9 shows that counts of station entries and exits in Arlington County were nearly equal during peak hours as well as the off-peak. During the morning rush hours, many of the county's Metrorail stations are both trip origins and destinations, meaning trains and buses are full in both directions. The presence of so much retail-entertainment-hotel activities along the County's metrorail corridors has further filled trains and buses during the midday and on weekends. Arlington County averages higher shares of transit boardings and alightings at its stations in off-peak hours than other jurisdiction in the region with the exception of downtown Washington, D.C. Balanced, mixed-use development has translated into as close to 24/7 ridership profile as any U.S. setting outside of a CBD.

In probing the ridership "bonus" of TOD, I examined yearly data on building activities and station entries/exits for Arlington County station areas over the 1985 to 2002 period. Using multiple regression equations that simultaneously estimated ridership, development, and service levels as joint functions of each other, the analysis revealed the following. Ridership has been most responsive to increases in office and retail development. Every 100,000 square feet of added office and retail floorspace increased average daily boardings by 50. Residential development increased ridership in part by prompting increases in service frequency. In combination, the two factors – new housing and more frequent headways – boosted patronage: every 100 additional residential units, when combined with 100 additional rail-car passenger spaces per day, led to more than 50 additional boardings per day.

Bus-Based TOD: Bogotá and Curitiba

Many medium-sized global cities cities are looking to Bus Rapid Transit (BRT) as the most affordable form of high-performance public transit investment. Two noteworthy

experiences with BOT and TOD are Bogotá, Colombia and Curitiba, Brazil.

Bogotá, the Andean capital of Colombia, has gained global recognition for its highly efficient and productive bus rapid transit (BRT) system, called Transmilineo.[5] For a city of 7 million inhabitants facing civil conflict and deep economic problems, Bogotá's emergence as one of the world's most sustainable metropolises is all the more remarkable.

In the late 1990s, Bogotá began operating a high-speed, high-capacity bus system, called Transmilenio, building upon Curitiba, Brazil's much-celebrated successes with dedicated busways. A big difference, however, is that Curitiba relies principally upon circular, cross-town bus routes to interconnect radial busways. Outside of downtown, relatively little was invested in pedestrian and bikeway improvements. Bogotá, on the other hand, actively embraced pedestrian and bicycle access.

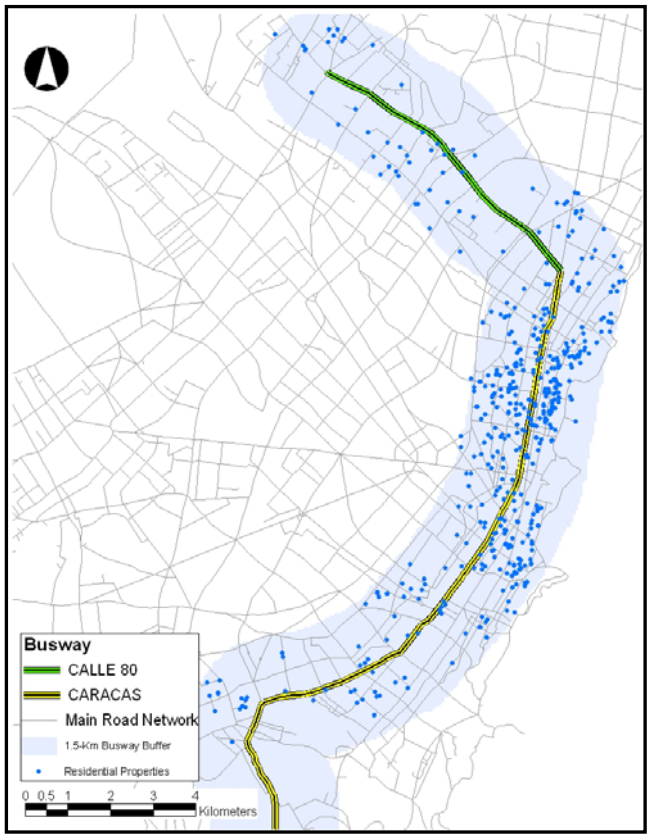
The 42-kilometer, 3-line Transmilenio busway is the centerpiece of Bogotá's vast bus network. (The dedicated system will eventually expand to 22 lines covering 391 kilometers.) Bus lanes are situated in boulevard medians, with weather protected, attractively designed stations spaced every 500 meters or so. Because of dual carriageways that enable buses to overtake each other and high-level platforms that allow expeditious boardings and alightings, Transmilenio has a throughput of some 35,000 persons per direction per hour, a number than matches that of many metro-rail system. Some 850,000 passengers ride Transmilenio buses each weekday, three times the ridership of two rail lines in Medellin, Colombia (achieved at less than one-fifth of the Medellin Metro's construction costs) and providing for a social rate of return of 61 percent.[6]

Particularly important to the transitway has been Bogotá's attention to pedestrian and bicycle access, in the form of "green connectors". Perpendicular and grade-separated pedways and bikeways connect some of the poorest barrios and informal housing settlements (with highly transit-dependent populations) to the busways. Other innovative features of Bogotá's sustainable transport program include license-plate rationing, parking management, and car-free districting. Bogotá is an extraordinary example of matching infrastructure "hardware" with public-policy "software": Latin's America's most extensive network of cycleways (250 km), the world longest pedestrian corridor (17 km), and the planet's biggest Car Free Day (covering an entire city of 35,000 hectares). Today, 43 percent of the city's transport investment budget goes to ancillary policy measures.

Transmilenio's numbers are impressive. Average bus speeds increased from 12 kph to 27 kph along the two busiest busway corridors. This led to a 32 percent reduction in average trip times for users of the system.[7] Accidents have fallen some 93 percent and and air pollution has improved: from 1999 when Transmilenio opened to 2001, injuries and collisions along bus-served corridors fell by 75 to 80 percent and sulfur dioxide, nitrogen oxides, and particulate matter had dropped 43, 18, and 12 percent respectively.[8] During its first year, Transmilenio had a 98 percent passenger approval rating. Eleven percent of Transmilenio riders are former car drivers.

While Bogotá's Transmilenio system has not dramatically altered the cityscape to date, at least when compared to cities like Curitiba, Brazil (as discussed later), recent research shows that commercial properties have reaped benefits from proximity to busway stations. Figure 3 shows properties that were surveyed by Targa and Rodriquez in a study of Transmilenio's land-rent capitalization impacts. Using hedonic price models, the authors measured a monthly rental discount of 1.87 percent for every additional 0.1 km from a BRT station, all else being equal.[9] This suggests a pent-up market demand for the accessibility benefits conferred by high-quality bus-based transit in cities of developing countries.

Figure 3. Commercial Properties Studied in Relation to Bogotá's TransMilenio System, 2002.



As with many successful transit investments, it has been the attention to design details, matched by good macro-scale planning, that has contributed to Tranmilenio's success. Car parking is mainly limited to the end stations of the Transmilenio busway. Nearly half of the 57 intermediate stations are served by skywalks/pedestrian overpasses. A phalanx of sidewalks and bikeways feed into all stations, most embellished by vegetative landscaping. Some two dozen civic plazas, pocket parks, and recreational facilities lie within a half kilometer of busway stops. Today, 45 percent of Transmilenio users reach stations by foot or bicycle.

Bicycle facilities extend well beyond Transmilenio stations. Currently, Bogotá boasts over 200 kilometers of dedicated bicycle paths and lanes. The Dutch-advised long-range plan calls for the figure to almost double over the next 30 years. The $178 million spent to date for bicycle improvements is about half the total amount the entire United States spends annually on cycling infrastructure. Over the past decade since bikeways have been introduced, the share of daily trips by cycling has grown from 0.9 percent to 4 percent. A hospitable environment has helped. Perched in a flat valley high in the Andes, Bogotá enjoys a mild climate. So have high densities (at 12,000 persons per square kilometer, Bogotá is one of the densest cities in the Western Hemisphere) and mixed land-use patterns. As a result, 77 percent of daily trips in the city are less than 10 kilometers. Bicycles can often cover 10 kilometers faster than cars because many of the city's traffic-snarled roads.

To further promote cycling, Bogotá officials have held car-free days on the first Thursday of February since 2000. On Sundays, the city closes 120 kilometers of main roads for 7 hours to create a "Ciclovia" ("Cycling Way") for cyclists, skaters, and pedestrians. When weather's good, as many as a million and a half cyclists hit the streets of Bogotá on Sundays. Bike-friendly initiatives have been matched by car-restricted ones. Through a tag system (Pico y Paca), 40 percent of cars have to be off of central-city streets during peak hours every day. Bollards have been installed throughout the core to prevent motorists from parking on sidewalks and bikeways.

How can a city in a developing country saddled with guerilla warfare and armed conflict, one might ask, justify investing scarce public resources in "amenities" like pedways and bikepaths? Aren't education, health care, sanitation, housing, and other pressing urban concerns of much higher priority? Bogotá's channeling of funds into the transport sector reflects, in part, the visions of several liberal mayors who have openly embraced smart-growth planning under the premise that a functional, world-class city can halt a brain drain and, over the long run, entice foreign capital and investment. The poor, they believe, will eventually benefit from better jobs and living conditions. Former mayor and now international planning consultant, Enrique Peñalosa, views the city's investments as social equalizers. He writes:

> A premise of the new city is that we want society to be as egalitarian as possible. For this purpose, quality of life distribution is more important than income distribution. The equality that really matters is that relevant to a child: access to adequate nutrition, recreation, education, sports facilities, green spaces and a living environment as free of motor vehicles as possible. The city should have abundant cultural offers; public spaces with people; low levels of noise and air pollution; and short travel times.[10]

The broader societal benefits of balancing growth along linear axes and aggressively pursuing a "transit first" policy is underscored by experiences in Curitiba, Brazil. Curitiba, widely viewed as one of the world's most sustainable, well-managed metropolises, is also one of the most accessible -- a product of some forty years of carefully integrating urbanization and transportation improvements. By emphasizing planning for people rather than cars, Curitiba has evolved along well-defined radial axes

that are intensively served by dedicated busways. Along some corridors, elephant-trains of double-articulated buses haul 16,000 passengers per hour, comparable to what much pricier metro-rail systems carry. A design element used to enhance accessibility is the "trinary" -- three parallel roadways with compatible land uses. An important benefit of mixed land uses and transit service levels along these corridors, besides phenomenally high ridership rates, has been balanced, bi-directional flows, ensuring efficient use of available bus capacity, just as in the case of Stockholm. On a per capita basis, Curitiba is one of Brazil's wealthiest city yet it averages considerably more transit trips than much-bigger Rio and São Paulo. It also boasts the cleanest air among any Brazilian city over 1 million inhabitants, despite being a provincial capital with a sizable industrial sector. The strong, workable nexus that exists between Curitiba's bus-based transit system and its mixed-use linear settlement pattern deserves most of the credit.

Conclusion

Global experiences show that integration of public transport and land use yields tremendous sustainability benefits. As long as TOD confers both public and private benefits, there is no replacement for public-private partnerships in advancing TOD implementation. Each party brings unique talents, insights, and resources to the table.

Even in car-dependent America, TOD resonates with the general public and often finds support across political and ideological lines. In America today, transit-oriented housing stands as one of the most promising mechanisms for promoting multiple urban policy objectives – affordable housing construction, sprawl containment, and reduced car-dependence. Bold new policies are beginning to surface across the U.S., ones that push conventional boundaries and acknowledge the unique market niches that are being served. These include market-based initiatives like Location Efficient Mortgages and unbundling of parking and housing costs as well as government incentives such as targeted infrastructure investments and the flexing of parking standards. Standard designs, cost *pro formas*, and building code templates need to be challenged for each and every transit-oriented project in large part because the TOD market is not "standard". Experiences show that new housing built near rail stops often appeals to singe professionals, childless couples, and empty-nesters who value amenities as much as the amount of living space and who often own fewer cars and log fewer miles on their odometers than the typical urban household. Standards for mortgage qualifications, building designs, and parking supplies need to reflect these market realities. To the degree that market-responsive policies are introduced, shifting demographics and lifestyle preferences will reduce the need for government subsidies and regulatory interventions, save for those that aim to help the poor. Ultimately, the marketplace will drive station-area planning and designs, with policy interventions focused mainly on making neighborhoods surrounding transit nodes better places to live, recreate, shop, and do business.

Perhaps it is the fact that TOD is centrally a market-based concept that it is taking a foothold in traditional car-dependent settings like the U.S. While critics charge that TOD is a form of social-engineering, in truth it is market based because it diversifies urban landscapes and modal options. As American and many other global societies becomes

more plural and heterogeneous, land-use and transportation arrangements that widen choices will allow individual households and firms to better satisfy their lifestyle and business preferences. Choice and variety are important elements of successful marketplaces. Fortunately, TOD enriches choices.

Of course, public interventions are a necessary ingredient of successful TODs. In this regard, global experiences demonstrate that leadership, combined with forward-looking urban planning and efficient pricing of scarce resources, provide the necessary complements to make TOD a viable and sustainable form of urbanism.

Notes

[1] J. Kenworthy and F. Laube, 1999, *An International Sourcebook of Automobile Dependence in Cities: 1960-1990*, Boulder, University of Colorado Press.
[2] Arlington County Department of Community Planning, Housing and Development, *Developments in the Metro Corridors – 2000*, July 2002.

[3] United States Census 2000 and Arlington County Department of Community Planning, Housing and Development.

[4] JHK and Associates, *Development-Related Survey I*, Washington, D.C., Washington Metropolitan Area Transit Authority, 1987; JHK and Associates, *Development-Related Survey II*, Washington, D.C., Washington Metropolitan Area Transit Authority, 1989.

[5] BRT aims to achieve the speed and performance advantages of grade-separated services at a fraction of the cost by cleverly using bus-based approaches. Among its key features are: exclusitivity, notably physical segregation; seamless (same-level) transfers; advanced bus technology: clean fuels, light-weight materials, low floors, advanced communications, docking systems; supportive armature: signal priorities, bus turnouts, curb realignments, automated vehicle location (AVL) systems, automated routing and dispatching; expeditious fare collection and boarding: off-vehicle payment, smart cards.
[6] Consejo Nacional de Politica Económica y Social, "Sistema de Servicio Publico Urbano de Transporte Masivo de Pasajeros de Bogotá", Departamento Nacional de Planeación, Documento No. 3093, 2000.
[7] E. Sandavol and D. Hildalgo, "TramsMilenio: A High Capacity – Low Cost Bus Rapid Transit System Developed for Bogotá, Colombia", 2002, Transmilenio, S.A., Bogotá, Colombia.
[8] *Ibid.*
[9] F. Targa and D. Rodriquez: Analysis of Bogotá's Bus Rapid Transit System and its Impact on Land Development", *Carolina Planning Journal*, Winter 2003-2004, pp. 26-36.
[10] See http://socrates.berkeley.edu:7001/Events/spring2002/04-08-penalosa/index.html.