Transport Policy 36 (2014) 127–138

Contents lists available at ScienceDirect

Transport Policy

journal homepage: www.elsevier.com/locate/tranpol

# BRT TOD: Leveraging transit oriented development with bus rapid transit investments

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ARTICLE INFO

Available online 16 September 2014

*Keywords:*
Transit oriented development
Bus rapid transit
Place-making
Land use
Urban form

ABSTRACT

Bus rapid transit (BRT) systems have gained prominence worldwide as a cost-effective alternative to urban rail investments. However, some question the city-shaping potential of BRT, in part due to a belief it delivers fewer regional accessibility benefits than rail, but also to the social stigma some assign to bus-based forms of mass mobility. Notwithstanding the successes of cities like Curitiba and Ottawa at integrating BRT and land development (Cervero, 1998. The Transit Metropolis: A Global Inquiry, Island Press, Washington, D.C.), doubt remains over BRT's ability to promote less car-dependent, more sustainable patterns of urban growth in rapidly motorizing and suburbanizing cities.

This paper probes the opportunities and challenges of leveraging transit-oriented development (TOD) through BRT investments. The policy context of BRT and urban growth is first described. Evidence on the influences of BRT on urban development and land values is then presented followed by discussions on density and ridership performance of BRT cities. Attention next turns to the fundamental tension of mediating between the logistical and place-making functions of BRT stations. Failure to do so has generally resulted in low-cost, high-performance investments at the expense of suppressing TOD opportunities. Case experiences in Bogota Colombia and Ahmedabad India underscore that near-term mobility gains took precedence over shaping urban growth over the long-term. The paper closes with discussions on implementation. Based on a survey of 27 global cities with BRT systems, tools introduced to date to leverage TOD are reviewed. Survey respondents also commented on barriers that stand in the way of BRT TOD in their cities. While BRT is often viewed as being suited to serving lower density, outlying settings, it is believed that under the right conditions, BRT can also be as influential in inducing urban redevelopment and shaping urban growth in more sustainable formats.



## 1. Introduction

Bus rapid transit (BRT) systems have gained prominence worldwide as a cost-effective alternative to urban rail investments. However, some question the city-shaping potential of BRT, in part due to a belief it delivers fewer regional accessibility benefits than rail, but also to the social stigma some assign to bus-based forms of mass mobility. Notwithstanding the successes of cities like Curitiba and Ottawa at integrating BRT and land development (Cervero, 1998), doubt remains over BRT's ability to promote less car-dependent, more sustainable patterns of urban growth in rapidly motorizing and suburbanizing cities.

This paper probes the opportunities and challenges of leveraging transit-oriented development (TOD) through BRT investments. The policy context of BRT and urban growth is first described. Evidence on the influences of BRT on urban development and land values is then presented followed by discussions on density and ridership performance of BRT cities. Attention next turns to the fundamental tension of mediating between the logistical and place-making functions of BRT stations. Failure to do so has generally resulted in low-cost, high-performance investments at the expense of suppressing TOD opportunities. Case experiences in Bogota Colombia and Ahmedabad India underscore that near-term mobility gains took precedence over shaping urban growth over the long-term. The paper closes with discussions on implementation. Based on a survey of 27 global cities with BRT systems, tools introduced to date to leverage TOD are reviewed. Survey respondents also commented on barriers that stand in the way of BRT TOD in their cities. While BRT is often viewed as being suited to serving lower density, outlying settings, it is believed that under the right conditions, BRT can also be as influential in inducing urban redevelopment and shaping urban growth in more sustainable formats.

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http://dx.doi.org/10.1016/j.tranpol.2014.08.001
0967-070X/

## 2. Policy context for TOD

Over the next several decades, around 90 percent of the world's urban population growth will be in the Global South (UN Habitat, 2011). If developing countries continue on their trajectories of the past decade – i.e., annual population growth rates of 2.5 percent and a decline in built-up densities of 1.5 percent a year – the world's cumulative area of built-up, impervious surfaces will double in 17 years and triple in 27 years (Angel, 2011). The long-term ecological consequences of converting land on a massive scale from natural habitats and open space to urban functions – e.g., diminished water supplies, increased carbon emissions, heat-island effects, and lost agricultural land – could be devastating.

Concentrating urban growth along high-capacity transit corridors is increasingly being recognized as a way to moderate climate change and increase the mobility of the poor. At the 2012 Rio+20 Conference, international development banks announced a "game changer" commitment to sustainable transport, pledging substantial financial support to public transport investments over the next decade (World Resource Institute, 2012). UN-Habitat's recently released *2013 Global Report on Human Settlements* concludes that public transport must become the highest priority form of motorized transport worldwide to put cities on a sustainable pathway. Bus rapid transit (BRT) plays a key role in creating sustainable futures by providing a cost-effective form of public transport.

BRT systems come in many shapes and forms however they all aim, to varying degrees, to mimic the high-capacity, high-performance characteristics of urban rail at a much lower price—according to one study, as much as 4 to 20 times less than light rail transit (LRT) and 10 to 100 times less than metrorail systems (Wright and Hook, 2007). The Institute of Transportation & Development Policy (ITDP) (CHINABRT.ORG., 2013), one of the technology's strongest proponents, defines BRT as "a high-quality bus-based transit system that delivers fast, comfortable and cost-effective urban mobility through the provision of segregated right-of-way infrastructure, rapid and frequent operations, and excellence in marketing and customer service". Operating buses on a separate, dedicated right-of-way or running-way is what chiefly distinguishes "high-end" BRT from lower quality (typically mixed-traffic) services, also called "BRT Lite". Curitiba, Brazil is credited with pioneering high-end BRT in the early 1980s. Former Curitiba mayor Jaime Lerner referred to the city's BRT system as a "surface metro" offering the best of both worlds: the speed and reliability of rail and the operating flexibility and lower cost of a conventional bus (Cervero, 1998; Deng and Nelson, 2011).

BRT is expected to play an increasingly prominent role in the global campaign for more sustainable transport and urban forms. This is partly because the bulk of future population growth will be in intermediate size cities, where BRT is often more cost-effective than its alternative, metrorail transit. According to UN Habitat (2011), most of the 2 billion new urban dwellers between now and 2030 will be in cities with populations of 100,000 to 500,000—places too small for cost-effective urban rail investments yet suitable for high-capacity, high-quality bus-based services. Future growth of population and economic outputs are likely to occur in intermediate size cities (Glaeser and Josh-Ghani, 2012). While case experiences with BRT and land-use integration reviewed in this paper focus on large cities, the opportunities and challenges discussed pertain to small and intermediate size cities as well.

## 3. Global BRT trends

To date, more than 160 cities have implemented some form of BRT worldwide, collectively carrying around 28 million passengers each weekday. The world's BRT systems comprise around 3000 corridors, 4400 km of routes, 6700 stations, and 30,000 buses (BRTDATA.ORG, 2013).

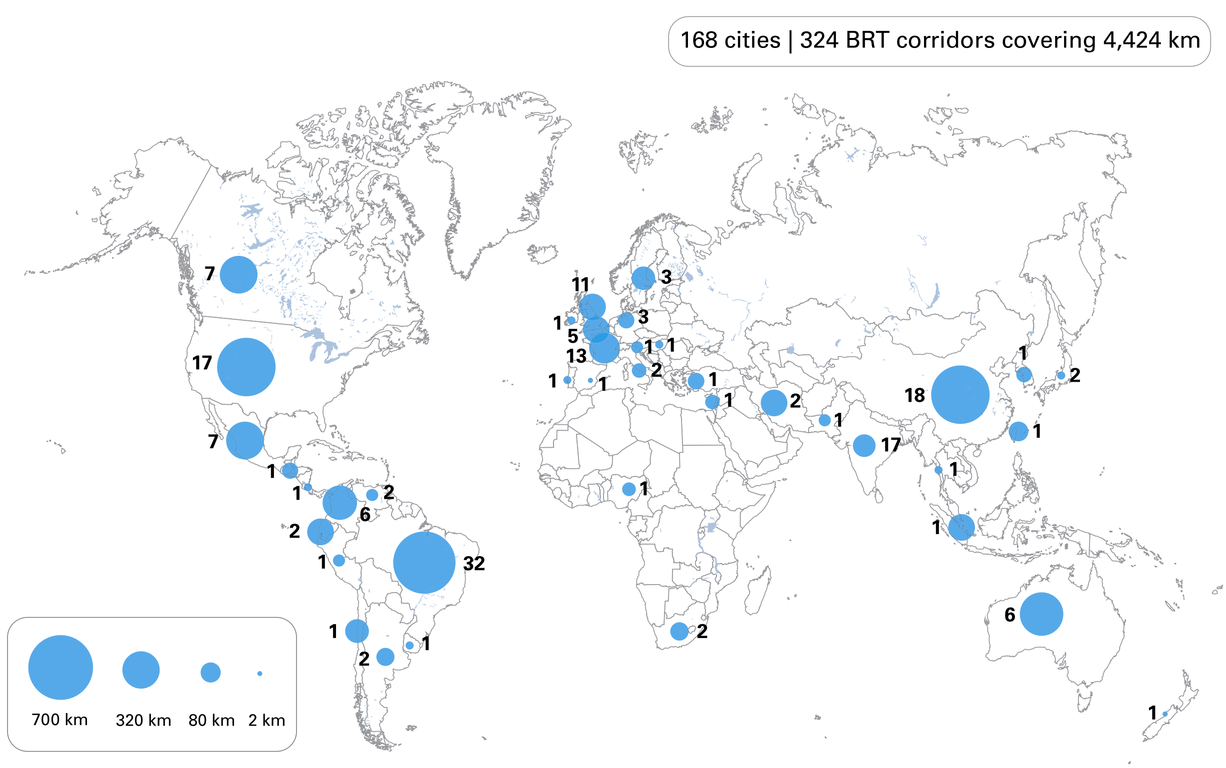


**Fig. 1.** World map of BRT systems, by country and route kilometers, 2014.
*Source*: BRTDATA.ORG (2013).

Rationales for BRT investments vary. Early BRT adopters, such as Curitiba and Ottawa, built busways mainly because they were more affordable than Light Rail Transit (LRT) (Cervero, 1998). Besides cost-savings, highly congested mega-cities like Jakarta, Bangkok, and São Paulo have been drawn to BRT because high-capacity transit can be built and expanded quickly at a time of rapid motorization and ever-worsening traffic congestion. The ability to open segments before an entire system is in place appeals to politicians seeking quick results. Seoul and Mexico City have recently opened BRT lines as robust complements to large-scale urban rail systems. To some developing cities that have historically lacked a viable public transit system, instead relying on a constellation of poorly coordinated private bus and informal paratransit services, BRT is part of a major transformation, serving as the backbone of a revamped public system. This characterizes cities like Lagos and Johannesburg. In much of Europe, particularly in medium-size cities, BRT – also called BHLS (Buses with High Level of Service) – is being introduced as a more affordable alternative to tramways in built-up areas, with a focus on enhancing service reliability, punctuality, and comfort along existing roadways (Finn et al., 2011).

Fig. 1 maps the number of BRT systems and route kilometers by country as of early 2014. The vast majority of these systems have been built in the last 15 years. Brazil has emerged as the global leader, extending the success of Curitiba's BRT pioneering system to 31 other cities. Other Latin American countries, notably Colombia and Mexico but also Chile, Peru, and Ecuador, have since followed Brazil's lead. Latin America is today the epicenter of the global BRT movement. A third of BRT route kilometers and nearly two thirds (63 percent) of ridership are in Latin America (BRTDATA.ORG, 2013). Latin American systems are also the most productive, averaging more than 2 ½ times as many weekday riders per BRT kilometer as Asian systems, more than 3 times as many as Oceana and African systems, more than 5 times as many as North American systems, and nearly 6 times as many as European systems (Fig. 2).

China is following Latin America's footsteps in aggressively building BRT, with more than ten cities, including Beijing, Hangzhou, Xiamen, Jinan, and Guangzhou, having opened dedicated-lane BRT services since 2005. Over the past eight years, China has added BRT lane-km at a faster pace than anywhere (Fig. 3). All have been high-end investments. Fig. 1 shows the world's most motorized country, the United States (797 motor vehicles per 1000 inhabitants), actually ranks third in number of BRT systems. However, with the exception of systems like Los Angeles's Orange line, Boston's Silver line, and Eugene, Oregon's EmX system, most could be described as BRT lite.

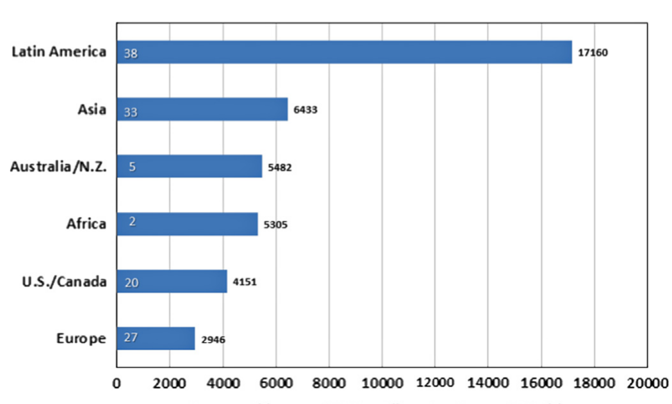


**Fig. 2.** Average weekday riders per BRT kilometer among BRT cities, by continent-region. Numbers in bars denote number of BRT cities in region that are included in the analysis.
*Source*: BRTDATA.ORG (2013).

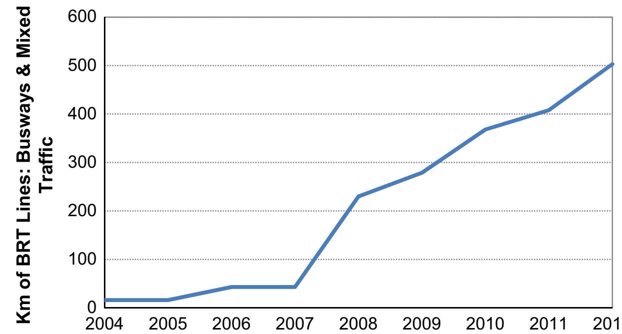


**Fig. 3.** Growth in China's BRT network lengths (in kilometers, two directions): 2004 to 2012.
*Source*: CHINABRT.ORG. (2013).

Notwithstanding the rapid pace of BRT investments of the past decade, there remains room for growth. In 2011, the nearly 28 million passenger trips served by BRT systems worldwide were but 2.2 percent of all public transport trips and a mere 0.3 percent of all motorized person trips made that year (Pourbaix, 2011).

## 4. BRT and urban development

One only has to look at the skylines of cities with world-class rail systems like New York City and Hong Kong to appreciate the powerful city-shaping influences of rail investments. Whether BRT can promote transit oriented development (TOD) – compact, mixed-use, pedestrian-friendly development organized around a transit station – on a significant scale largely remains an unsettled question.

TOD is widely viewed as an inherently efficient and sustainable urban form (Calthorpe, 1993; Curtis et al., 2009). Well-designed TOD, experiences show, increases and serves as a hub for organizing community development and revitalizing long-distressed urban districts (Bernick and Cervero, 1997; Cervero, 1998). BRT seems particularly suited to the low-to-moderate density, residentially oriented market niche of TOD (Dittmar and Ohland, 2003; Chen, 2010).

Skepticism over the city-shaping potential of BRT stems partly from the view that it delivers fewer regional accessibility and connectivity benefits than faster, more geographically extensive rail services (Vuchic, 2007). The absence of a fixed guideway or high-profile infrastructure is also thought to dilute bus-transit's development potential in minds of real-estate developers, who can never be sure of the service features of future bus operations. The spewing of diesel emissions and the social stigma attached to transit-dependent (and thus often lower income) users also detract from bus-transit's image.

Where bus-based systems begin to mimic the fixed-guideway, high-quality service features of rail-based systems, and thus shed negative social and environmental stereotypes, is where dedicated and exclusive (and sometimes fully grade-separated) lanes are provided. Dedicated-lane BRT not only holds the potential to confer regional accessibility benefits that are similar to those of metrorail systems, and thus exert comparable impacts on urban form, but also offers flexibility and versatility advantages that rail-based systems do not (Cervero et al., 2004; Currie, 2006). Notably, the same vehicle that provides speedy line-haul services can leave the guideway or dedicated lane, morphing into a feeder vehicle that circulates in lower density areas. Marrying the line-haul and collection-distribution portions of trips in a single vehicle makes

BRT particularly well suited for smaller, lower density cities, an observation made by Meyer et al. (1965) nearly a half-century ago. In *The Transit Metropolis*, bus-based systems are considered more “adaptive” to cityscapes, both serving existing built forms and shaping future ones (Cervero, 1998).

Empirical evidence on BRT's city-shaping impacts is limited. Levinson et al. (2002) reported significant development activities around BRT stops in Pittsburgh, Ottawa, and Adelaide, however the absence of control or comparison sites confounded the ability to associate this growth to the presence of improved transit services. Land-price capitalization benefits of BRT investments have been reported in Brisbane (Levinson et al., 2002), Los Angeles (Cervero, 2004), Pittsburgh (Perk and Catala, 2009; Diaz and Hinebaugh, 2009), Nantes and Rennes (Finn et al., 2011), Bogotá (Rodriquez and Targa, 2004; Rodriquez and Mojica, 2009; Munoz-Raskin, 2010), and Seoul (Cervero and Kang, 2011). In Los Angeles, land value impacts were small and accrued only to commercial parcels (Cervero, 2004). In contrast, studies of Bogotá's more substantial BRT system have found appreciable land-value benefits (Rodriquez and Targa, 2004; Rodriquez and Mojica, 2009; Munoz-Raskin, 2010). There, multi-family housing units close to Bogotá's TransMilenio BRT rented for more per square meter than units located farther away (Rodriquez and Targa, 2004). There is also some evidence that creating pedestrian-friendly environments near BRT bus stops can further increase land-value benefits (Estupinan and Rodriguez, 2008).

1977; Ewing and Cervero, 2010). Mass transit, it is said, needs “mass”, or density, to be cost-effective. Curitiba's BRT – which carries 45 percent of motorized trips in the city, the highest share in Latin America (Santos, 2011) – relies on concentrated densities and mixed-use development along radial corridors to draw travelers to buses. Building heights systematically taper with distance from BRT corridors, wedding-cake style. The first two floors of buildings, which do not count against floor area ratios (FARs), are for retail use. Offices often lie above retail uses. Inclusion of upper-level housing entitles property owners to density bonuses, which has led to vertical mixing of uses within buildings. Besides extraordinarily high ridership rates, mixed uses along linear corridors have resulted in balanced, bidirectional flows. During peak periods, buses are full in both travel directions, ensuring efficient use of bus capacity. Those living in low-density, outlying areas off BRT corridors still tend to take BRT. In 2009, for example, 78 percent of trips boarding at the terminus of Curitiba's north–south BRT corridor ended at a stop on the same corridor (Duarte and Ultramari, 2012).

The relationship between ridership productivity (riders per BRT km) and urban densities was explored for 119 BRT cities for which reliable data could be obtained. Based on population density data for geographic areas corresponding to BRT service jurisdictions and kilometers of BRT lines from the BRTDATA.ORG web site, the following log-linear regression equation was estimated:

$$\text{Ln(BRT ridership)} = \underset{(.000)}{5.828} + \underset{(.001)}{0.393}\ \text{LN(Population density)} + \underset{(.000)}{0.714}\text{(BRT kilometers)}$$

$$R^2 = .286; \quad F = 23.55(.000); \quad N = 119; \quad \text{LN} = \text{natural log}; \quad P - \text{values shown in brackets}$$

To many politicians, at least as important as land-use impacts is the potential of transit investments to spur economic growth. In its *Liveanomics* series, the Economist Intelligence Unit (2011) found that 61 percent of surveyed mayors felt that “improving public transport/roads” would make their city more globally competitive than any public investment (Economist Intelligence Unit, 2011). This was nearly twice the share that felt investing in schooling and education was the key to being economically competitive. Recent evidence from Eugene's EmX system suggests BRT can attract high-end, high value-added jobs. Using shift-share analysis, Eugene's BRT stations were associated with high concentrations of jobs in the management, educational services, health care, entertainment, and accommodation sectors (Nelson et al., 2013).

Ottawa and Curitiba arguably remain the best global examples of BRT TOD. As BRT pioneers, city leaders carved visions early on in the planning of both systems to use BRT to channel growth along well-defined linear corridors (Cervero, 1998). In both instances, BRT was envisaged as not only a mobility investment but also an opportunity to shape urban growth in a more sustainable, transit-oriented format (Suzuki et al., 2013). Local governments proactively leveraged TOD through zoning reforms, pro-development tax policies, assistance with land assemblage, and supportive infrastructure investments (Cervero, 1998). In Curitiba, local government mandated that all medium- and large-scale urban development be sited along a BRT corridor. Implementation tools being introduced to leverage BRT TOD across a sample of global cities are addressed later in this paper.

## 5. Density and BRT performance

Urban densities have a strong influence on transit ridership, whether for bus-based or rail systems (Pushkarev and Zupan,

Controlling for the total kilometers of BRT routes, the elasticity between population density and ridership was moderately positive: a doubling of population densities is associated with nearly a 40 percent rise in BRT ridership. This is considerably higher than the mean elasticity between population density and transit ridership of 0.07 reported in a meta-analysis of 10 different empirical studies of US cities (Ewing and Cervero, 2010) and consistent with the argument of some observers (Zegras, 2004; Cervero et al., 2009; Cervero, 2013) that built environments have stronger influences on travel behavior in rapidly growing cities than more mature ones.

While important to cost-effective BRT, densities need not be as high as for light-rail or heavy-rail (metrorail) services. A recent US study examined the job and population densities needed to produce capital costs-per-rider that fell in the top performance quartile of recent light rail, heavy rail, and BRT investments (Guerra and Cervero, 2011). A BRT system that costs US$50 million per mile (or per 1.61 km) needs at least 18 jobs and residents per acre (or 45 per hectare) within a half of mile (or .8 km) of its station to be in top 75 percent of cost-effective investments. A light-rail investment at the same per-mile cost needs nearly 50 jobs and residents per acre (or 125 per hectare) and a heavy-rail investment needs nearly 60 per acre (or 150 per hectare) to fall in the top quartile.

Lower density thresholds for cost-effective services bode well for BRT given global trends. From 1990 to 2000, average urban densities fell from 3545 to 2825 people per km$^2$ in developed countries, declining in all 32 developed cities surveyed by the World Bank (Angel, 2011). Because of the inherent flexibility advantages of rubber-tire buses over steel-wheel/steel-rail technologies, BRT is well-suited to serving lower density or spread-out development patterns. Chinese cities, for example, tend to have fairly evenly distributed urban densities (Yang et al., 2012). Their spread-out, planar urban forms are suited for flexible, multi-directional transit services. Rather than radial BRT systems with transfer points, as in Curitiba, Chinese cities like Guangzhou tend to have what are called direct-line systems—branching networks wherein numerous bus routes converge on a single dedicated BRT corridor, each serving different origin-destination patterns. Guangzhou's BRT system is highly productive, carrying 27,000 passengers per direction per peak hour in 2010, 2 ½ times more than in any of the 15 major BRT systems in Asia (CHINABRT.ORG., 2013). The ability to perform well in high-density corridors like Curitiba as well as more spread-out cityscapes as in Guangzhou speaks to the inherent versatility and flexibility advantages of BRT systems.

## 6. Challenges of BRT and land-use integration in the developing world

In terms of BRT's influences on urban form, cities like Curitiba and Ottawa are more the exception than the rule. To date, BRT systems worldwide have struggled to intensify land development or fundamentally alter or reshape the cities they serve. Next, case experiences with leveraging BRT TOD are explored in two large cities with extensive BRT systems: Bogotá, Colombia and Ahmedabad, India. A combination of site visits, informant interviews, and secondary information were relied upon in conducting case studies.

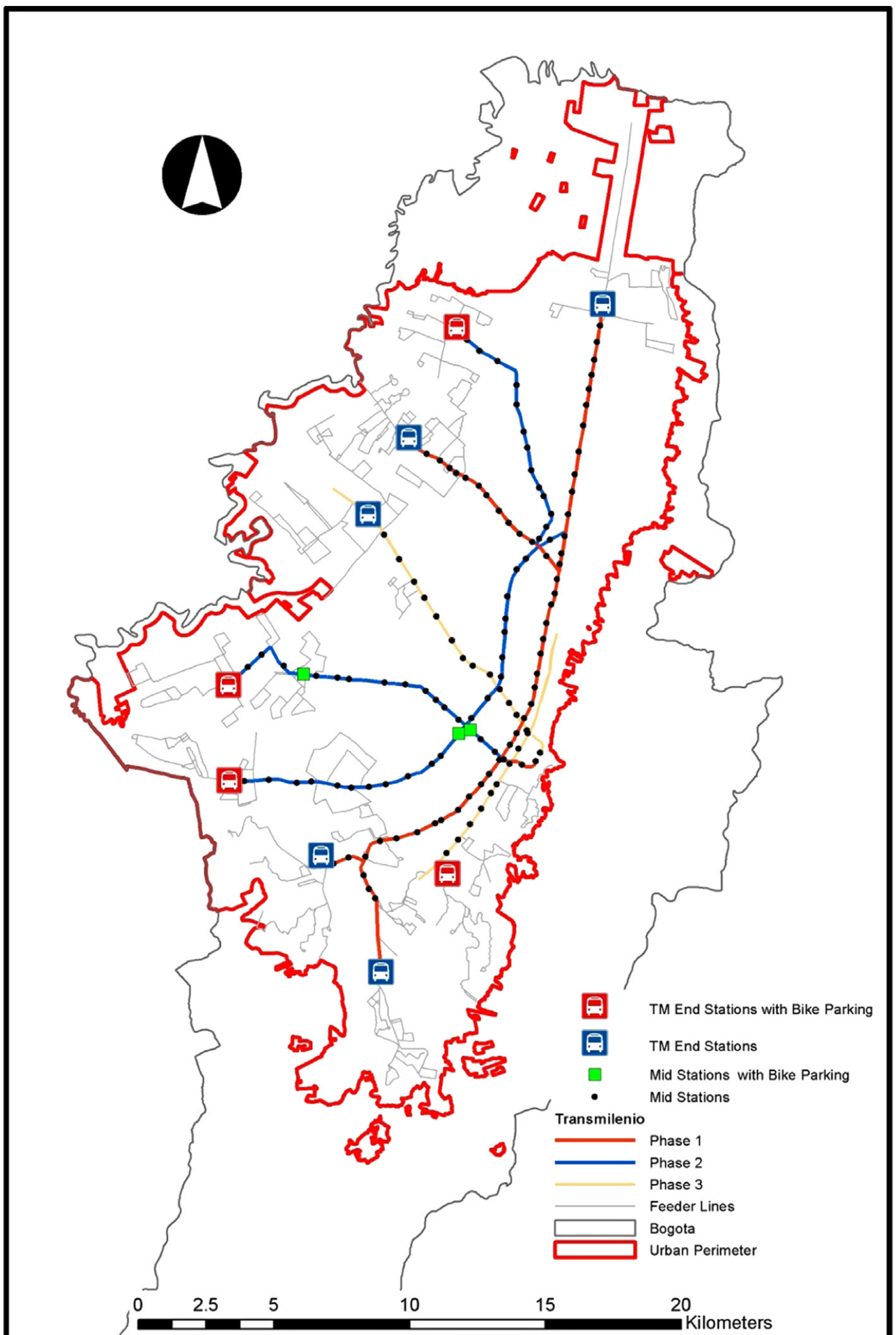


**Fig. 4.** Bogotá's TransMilenio BRT system: phases 1, 2, and 3.
*Source*: Suzuki et al. (2013).

### 6.1. Bogotá, Colombia

Bogotá, the capital of Colombia and home to 7.6 million inhabitants, has gained a reputation as one of the world's most progressive cities, underscored by the 2000 opening of what has been called the gold standard of BRT, the 84-km TransMilenio system. Delegations of officials and dignitaries from around the world visit Bogotá to marvel at its technological advancements. While its carrying capacity of some 45,000 passengers per direction per hour is said to match that of many metro systems, unlike Curitiba, reshaping urban form and land-use patterns has not been a primary focus.

Bogotá's planners designed a trunk-feeder system, marked by segregated, exclusive-lane bus operations on several major arterial roads and feeder buses operating on regular roads that tie into end-of-the-line stations. The system was built over three phases. Phase one opened 42 km of high-capacity BRT services mostly in the medians of two major arterials. Phase two, which opened in 2007, added another 42 km of mostly median-lane services, and the third phase, currently under construction, will add 28 km, for a 112 km system at build-out (Fig. 4). Feeder buses, which add 200 km of service coverage, operate at no-charge in low-income neighborhoods on the urban periphery. Today, TransMilenio's daily ridership exceeds 2 million, accounting for around three-quarters of total public transport trips in the city (Suzuki et al., 2013).

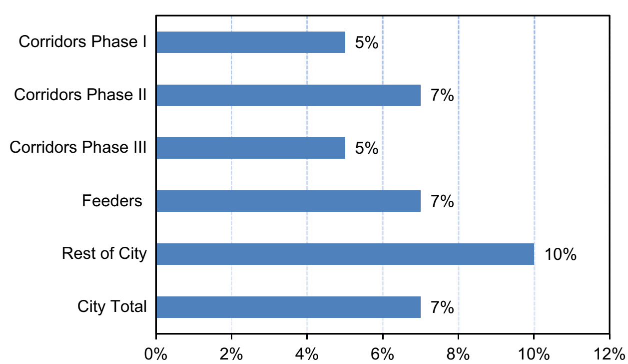


**Fig. 5.** Percent changes in building floor area ratios for impact zones of Bogotá's BRT corridors and feeder lines compared to the rest of the city and citywide totals, 2004 to 2010.
*Source*: Suzuki et al. (2013).

Since TransMilenio's 2000 opening, Bogotá's population has grown by 21 percent. Building densities have increased throughout the city, but mostly in areas away from TransMilenio corridors. The initial TransMilenio lines were built quickly in response to worsening traffic congestion, but also to build political momentum and curry political favor for future expansions. Aligning corridors in mostly economically stagnant zones that were largely built out has suppressed land development. So has the siting BRT in busy roadway medians, which limited land supplies for leveraging TOD and resulted in mostly unattractive pedestrian environments immediate to stations. Minimal pro-active station area planning or incentives for private property-owners to redevelop parcels also tempered TOD activities.

Cadastral data obtained from the city of Bogotá for the 2004–2010 period reveals the degree to which urban growth turned its back on TransMilenio. Stations' impact zones were set at 1000 m, corresponding to BRT's walkshed. For feeder bus lines, a 500 m impact zone was selected. Using data on floor area ratios (FAR—i.e., building area divided by land area) for all of Bogotá's registered residential and commercial buildings, Fig. 5 shows that building densities increased by 7 percent throughout the city. For TransMilenio corridors, densities increased 5 percent in Phase I and slightly more in Phase II, and by 5 percent for the Phase III corridor now being built. Less densification occurred after Phase I than for subsequent phases partly because TransMilenio's initial lines were built along corridors that were already developed. The nearby stock of mostly old, decrepit 2–3 story residential buildings were left untouched following TransMilenio's opening.

More building activities occurred near feeder lines, which witnessed a 7 percent increase in FARs between 2004 and 2010. The availability of comparatively low-cost vacant parcels and opportunities to convert informal housing to higher-quality formal housing accounted for higher levels of building near peripheral feeder lines. By comparison, the rest of the city, representing the non-impact-zone of BRT, saw a 10 percent increase in building densities over this period. Overall, the average building density

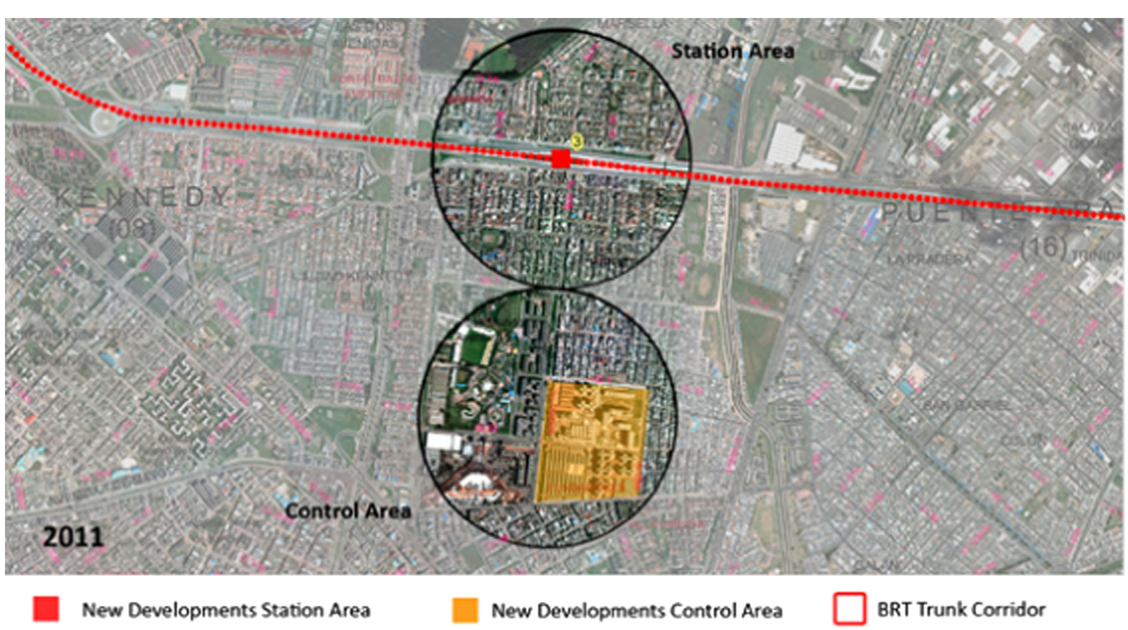


**Fig. 6.** Footprints of new developments in station area and control area for an intermediate station, 1998 to 2011.
*Source*: Suzuki et al. (2013).

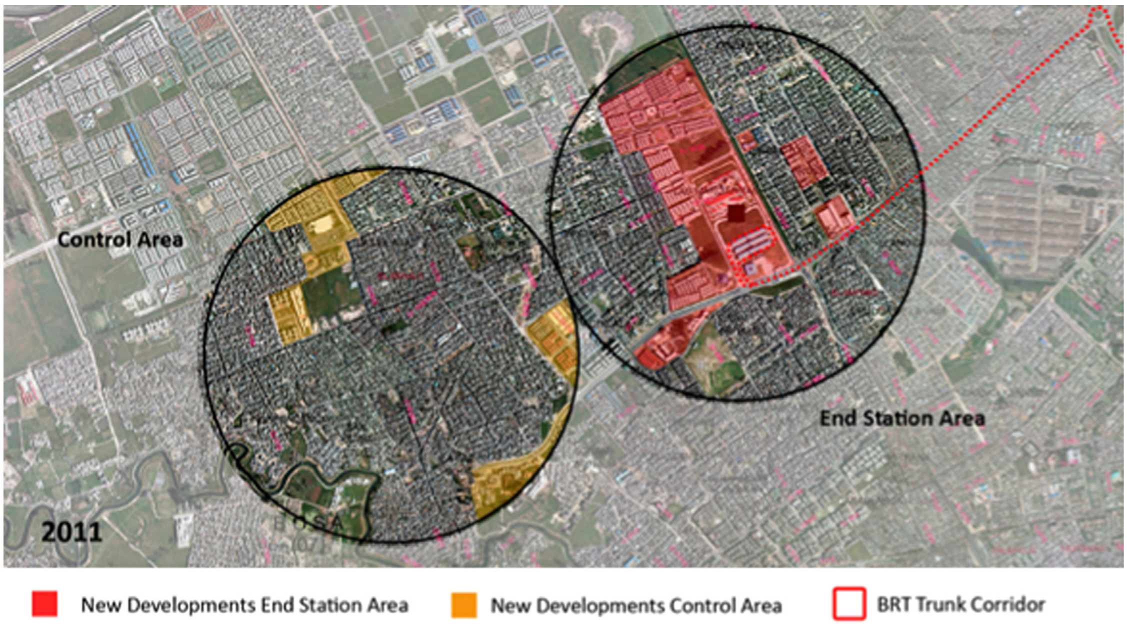


**Fig. 7.** Footprints of new developments in station area and control area for an end-of-the-line station, 1998 to 2011.
*Source*: Suzuki et al. (2013).

increase was 6 percent for areas near trunk and feeder lines versus 10 percent for the rest of the city.

More fine-grained match-pair comparisons further reveals TransMilenio's weak land-use connection. Changes in building area footprints were examined for 1-km radii around BRT stations and control areas (non-BRT stations) that are otherwise very similar (e.g. in terms of neighborhood incomes, land uses, and sub-regional locations). Changes in building footprints between 1998 and 2011 were compared between BRT stations and control areas for four intermediate stations (i.e., stations not at the ends of lines) as well as three pairs of end-of-the-line stations. For intermediate stations, more building activity was found away from than near stations. Fig. 6 shows one paired comparison for an intermediate station on a Phase II line toward the southwest of the city, near the low-income neighborhood of Kennedy. Far less new development occurred within 1000 m of the BRT station than the control area off the line. For terminal stations, however, there tended to be more new building activities than in control areas, as revealed by one of the matched-pair comparisons shown in Fig. 7, for the Americas terminal station. Other researchers have similarly found more land-use densification near TransMilenio's terminal stations than control areas (Bocharejo et al., 2013). This higher degree of station-area activities was largely due to the commercial opportunities at terminals, representing busy transfer points between feeder buses and trunkline BRT services.

The fact that comparatively little development has occurred around many of Bogotá's BRT stations supports findings from earlier assessments of transit investments and urban development (Knight and Trygg, 1977; Cervero and Seskin, 1995; Cervero and Landis, 1997). Transit cannot overcome weak local real estate markets, and station siting also matters. Placing stops in the medians of active roadways inevitably means a poor-quality pedestrian-access environment and thus little commercial development near the stations themselves. TransMilenio's design gave little weight to the pedestrian experience. The visually prominent skywalks that connect to BRT stops create lengthy, circuitous walks, can be noisy (resonating like steel drums during peak traffic conditions, by some accounts), and can be difficult for the elderly, disabled, and semi-ambulatory individuals to negotiate. Bogotá's experiences further show that planning matters. Neither the city nor neighborhood districts (where detailed land use planning is regulated and implemented) prepared station-area plans to orchestrate private development, change zoning (including increasing permissible densities), introduce complementary improvements (like streetscape enhancements) to entice private investments, or take any other pro-active steps to leverage new development.

### 6.2. *Ahmedabad, India*

In the 2009, Ahmedabad opened India's first and what today remains the country's largest BRT network. Called Janmarg ("People's Way"), the current 45 km system was built to relieve mounting traffic congestion in India's fifth largest city. With some 5.5 million inhabitants, Ahmedabad is listed as one of the world's fastest growing cities (Forbes, 2010). The ingredients are thus there for BRT to shape future urban growth: rapid growth and motorization coupled with increasingly worsening traffic congestion that increases market demands for transit-accessible locations. To date, however, few significant changes have occurred near Janmarg stations.

As in Bogotá, Janmarg was envisaged and designed as a mobility investment, not a city-shaping one. Short-term political priorities took precedence over long-term sustainability ones. Janmarg, slated to span some 220 km at build-out (Fig. 8), was aligned according to both cost-minimization and accessibility principles—20 percent of Ahmedabad's population lives within one kilometer of the 45-km phase-one system and this share is expected to increase to 73 percent when the entire system is built. Janmarg lines were and are being selected to serve the city's fastest growing areas, more so than in the case of Bogotá. However, little attention has been given to the physical integration of BRT stops with surrounding neighborhoods through the design of perpendicular pedestrian connections or increasing the share of future populations and workers clustered within a block or two of BRT. A fairly high-end system is being built by standards of Asian cities – dedicated and exclusive lanes with some grade-separations and full-service bus stations – thus the city-shaping potential of Janmarg is high.

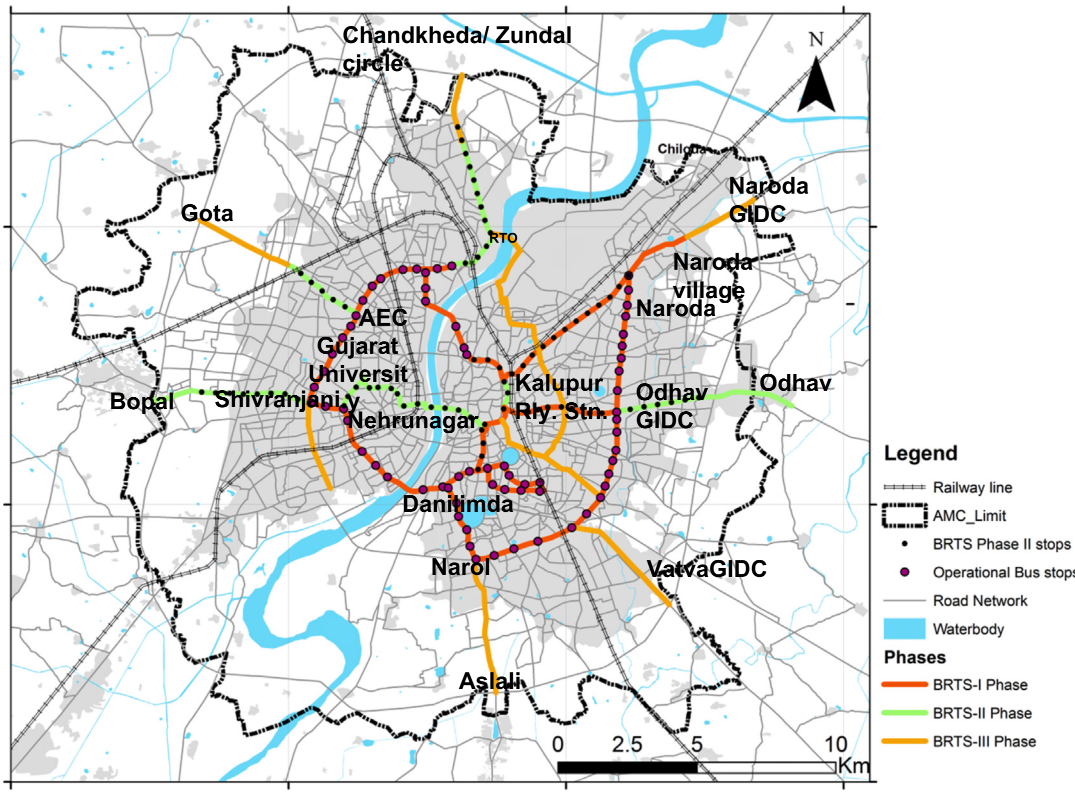


**Fig. 8.** Ahmedabad Janmarg BRT system: phases 1, 2, and 3.
*Source*: Suzuki et al. (2013).

To date, no land-use or TOD plans have been developed for any Janmarg stations. What land development is occurring has been left mostly to private market forces. Janmarg serves mainly built-up areas of the city, where land for new development and densification is limited. Most high-end commercial growth is now occurring in knowledge-based employment zones west of the city, featuring tall, modern buildings on superblocks with few pedestrian-ways in between and far removed from existing or planned BRT. There has been some brownfield redevelopment of former state-owned textile mills, once the economic backbone of the city, including sites near Janmarg stations. However redevelopment has been slow, mainly due to unsettled legal issues.

Notwithstanding the city's tepid stance on TOD, land markets appear to be responding to Janmarg's presence. Prices of land near stations nearly doubled between 2006 and 2011 (Suzuki et al., 2013). Seeking to reap profits, individual property developers have built individual projects near some stations, however absent station-area plans, piecemeal development has failed to add up to coherent or well-integrated transit-oriented development. Interestingly, Ahmedabad is as well suited as any city in the developing world to prepare TOD plans due to its long-time use of a "Town Planning Scheme". This is essentially a land-readjustment program that allows local government to assemble irregular-shaped agricultural and informal plots of land and to create functional and fully serviced housing and mixed-use developments from the consolidated parcels. Since its introduction in 1915, nearly three-quarters of the city's 300 km$^2$ land area has been developed under this scheme. Also conducive to TOD is Ahmedabad's ability to grant density bonuses as a means of generating revenues. In 2002, a law was passed allowing the sale of additional FAR for properties abutting streets 18 m wide or wider, which includes all BRT corridors. The current permissible FAR of 1.8 can be increased to 2.25. In 2011, 4.5 percent of Ahmedabad's total revenue came from this "guidance value" density-bonus scheme. City officials are currently considering raising FARs for properties near a proposed metro and BRT corridors to 3.5. Recapturing the added value created by transit would allow the city to generate much-needed funds to not only pay off transit capital investments but also to improve neighborhoods around stations, as successfully as Hong Kong's Rail+Property program (Cervero and Murakami, 2009).

So far, Ahmedabad officials have opted to maintain uniform densities throughout the city, regardless of how close parcels might be to transit corridors. This has been done to disperse trips and thus decongest the city. It has also been done for socio-cultural reasons, namely to avoid creating a privileged class of land owners whose new-found wealth is created through government fiat. However keeping densities uniform also shifts growth to the periphery, in a more auto-oriented configuration. In the near term, the city may experience less traffic congestion as a result of density caps. However, over the long term, the resulting auto-oriented urban form that unfolds could backfire, creating more traffic congestion and air pollution for the region as a whole.

The practice of spreading growth to decongest the core had been adopted not only in Ahmedabad but virtually in all large Indian cities. A sample of city centers in large Indian cities found an FAR of 1.6, lower than permissible densities in the suburbs (Bertraud, 2002; Glaeser, 2011). Like a tube of toothpaste, restricting growth in one place simply pushes new growth elsewhere, particularly from transit-served urban cores to more auto-oriented peripheral zones.

Several design shortcomings also need to be overcome if Ahmedabad is to spawn TOD. Janmarg was and is being designed as a closed system, requiring users to access stations sited in the medians of roadways by foot, bicycle, car, two-wheeler, three-wheelers, and surface-street buses. Little attention has been given to perpendicular connectors to BRT stops. No secondary feeder systems were designed at the time Janmarg was built to ensure efficient and safe pedestrian, bikeway, and transit connections to mainline services. While a substantial network of cycletracks was built in conjunction with Janmarg, for the most part, bike-paths run parallel rather than perpendicular to the busway, thus functioning more like competitive than complementary systems. Moreover, there is no bicycle parking at stations. What few pedestrian ways exist near Janmarg stops are often occupied by motorcycles and fast-moving three-wheel vehicles.

### 6.3. Case summary

Experiences in Bogotá and Ahmedabad suggest the failure to leverage compact, mixed-use development near stations stems from BRT systems being viewed mainly as mobility rather than city-shaping investments. In both cases, engineering, cost-minimization principles generally won out over urban-planning, development-maximization ones. In the drive to economize on investment costs, the path of least resistance was often chosen. This has meant siting BRT lines and stations in the medians of busy roadways, often with poor pedestrian access, to reduce right-of-way acquisition and avoid the cost of building demolitions and relocations. Costs have also been minimized by routing corridors in economically depressed and marginalized urban districts where land is not only cheap but the risks of a Not-In-My-Backyard (NIMBY) backlash were minimal. There is nothing inherently wrong with siting transit lines in least-cost corridors. Fiscal realities often dictate that this be the case. However, when it comes to the access points of these lines, namely stations, consideration should be given to selectively off-lining some stations and incurring higher upfront investment costs in order to site stations on land parcels that are most likely to spawn TOD. This occurred in both Curitiba and Ottawa, and while land-acquisition and station development costs increased in both cities in the near-term, the resulting transit-oriented built-form has yielded significant downstream benefits (Cervero, 1998; Duarte and Rojas, 2012; Suzuki et al., 2013).

## 7. TOD implementation tools and barriers in BRT cities

If TOD is to take form, BRT cities like Bogotá and Ahmedabad must first be committed to long-run strategic planning at multiple scales—regional, corridors, and station areas. The absence of station-area development plans inhibited compact, mixed-use, pedestrian-friendly development in both cases. Long-range plans, however, must be supplemented by specific instruments and policy levers that pave the way to implementation. It is well established that transit investments, paper maps, and illustrative plans, by themselves, are not capable of spurring TOD (Knight and Trygg, 1977; Cervero et al., 2004). They must be accompanied by


**Fig. 9.** Twenty-seven BRT cities responding to survey.

specific actions and tools – e.g., higher permissible zoning densities, the targeting of supportive infrastructure improvement to accommodate new growth, assistance with land assembly, and the removal of local blight – if private capital is to be attracted to transit corridors. This is all the more important for BRT given its limited experiences in leveraging land development and the risk-averseness of investors in today's real estate markets. To move from planning visions to execution, finding the right mix of implementation tools is essential.

In an effort to expand beyond the two case experiences reviewed in this paper and to explore implementation tools that have been introduced to promote BRT TOD, an on-line survey was prepared and administered in early 2013. We reached out to more than 50 global cities with BRT systems, seeking a representative sample with respect to geography and type of BRT system. Twenty-seven fairly complete and what were considered to be reliable responses were received. Survey respondents were mostly urban planners or transit planners who were familiar with their local BRT systems. Fig. 9 maps the cities that responded to our survey.

Respondents were asked to identify implementation tools – pertaining to infrastructure improvements, zoning and regulation, planning and financing, and land management – that had been introduced at one or more existing BRT stations in their cities. They were also asked to rate the effectiveness of each tool that had been introduced on a 1 to 5 scale, with 1 indicating low and 5 indicating high levels of effectiveness.

Fig. 10 summarizes the implementation tools and their perceived effectiveness introduced by the 27 surveyed BRT cities. The most common tool introduced to date in leveraging TOD was the targeting of infrastructure improvements, such as expanding trunk-line sewerage capacity or upgrading sidewalks, in BRT station areas. Moreover, targeted infrastructure improvements averaged the highest effectiveness rating—3.45. The next most common tool, introduced by more than half of surveyed cities, was zoning incentives, such as density bonuses for commercial buildings near BRT stops. Higher FARs tended to be granted in return for providing affordable housing units. Zoning incentives, moreover, received the second highest effectiveness rating. Next in order of commonness were the dedication of funds—specifically for capital improvements used for TOD, like streetscape improvements (48.1 percent of respondents) and for preparation of specific TOD plans (37 percent of respondents). Hypothecation of funding for TOD capital improvements and spatial planning also received high effectiveness ratings. Fig. 10 shows that one-third of responding cities have streamlined permitting processes or relaxed zoning restrictions (e.g., lower parking requirements) around BRT stations, tools that received moderate effectiveness rating. Less frequent, used by fewer than one-fifth of surveyed BRT cities, were tools tied to financing (e.g., benefit assessment, tax increment financing, tax exempt bonds) or land policies (e.g., eminent domain for acquisitions, underwriting land assemblage costs, and direct government land purchases). These tend to be bolder, more politically sensitive tools that directly impact municipal budgets and risk redirecting funds from competing urban programs, thus the more limited use of these tools was not unexpected.

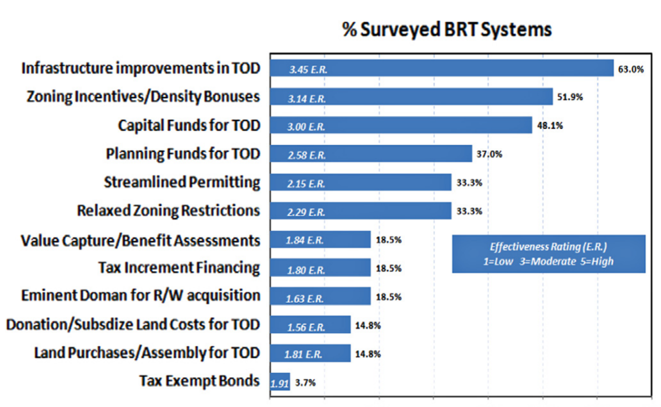


**Fig. 10.** Ranking of implementation tools to leverage BRT TOD and effectiveness rating of tools among 27 surveyed BRT Cities.

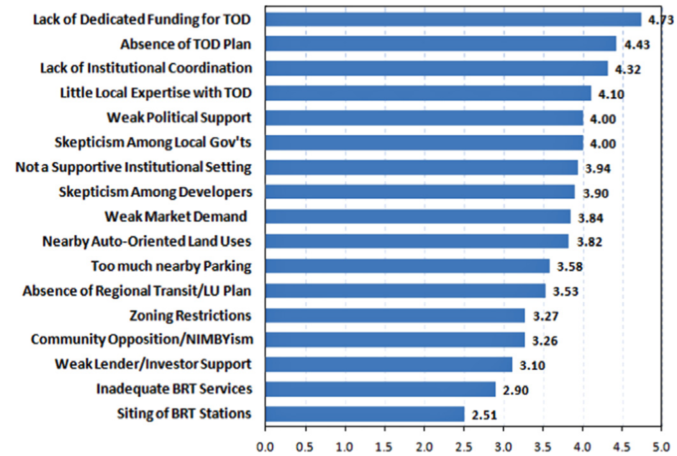


**Fig. 11.** Ranking of perceived barriers to BRT TOD among 27 surveyed BRT cities.

Interestingly, Fig. 10 reveals a fairly strong correlation between the prevalence of a tool and its perceived effectiveness. When available, planners seem inclined to introduce tools that are, or at least perceived to be, fairly effective at leveraging BRT TOD.

A second set of survey questions asked local planners to identify the most significant barriers to implementing TOD along BRT corridors and near BRT stations. In general, the most serious impediments to BRT TOD relate to weak institutional support and an absence of resource commitments needed for successful implementation. Fig. 11 presents the findings. Many of the factors listed in Fig. 11, we note, are inter-related, thus headway made in overcoming some barriers would likely help overcome other ones that are listed.

Heading the list of implementation barriers is the absence of dedicated funding for TOD. Given that saving costs is a chief reason that cities opt for BRT over rail investments, "soft costs" for TOD features such as streetscape and public-space enhancements tend to lie far down the funding priority list of many BRT projects. Related to this is the absence of resources needed to prepare station-area TOD plans that orchestrate and stage development, identified as the second most significant barrier. Next are a set of institutional factors—lack of inter-agency coordination, limited local experience with TOD, weak political support, and skepticism among local governments about the effectiveness of BRT TOD in solving local problems. In open comments, several survey respondents mentioned that bureaucratic inertia more generally slowed any concerted effort to work across stakeholder groups in building coalitions in creating TOD. Interesting, factors related to BRT itself – e.g., service intensity and quality or the siting of stations (e.g., in the medians of busy motorways – were perceived to form comparatively modest barriers to BRT TOD.

Weighing the findings summarized in these two figures, it appears that BRT planners are well aware of lessons gained from past urban rail systems with regard to leveraging TOD. Tools that work with the development process (e.g., providing supportive infrastructure and zoning) and tend to the responsibilities of the public sector (e.g., providing the funds needed for capital improvements and station-area planning) have been most common among BRT cities. BRT planners, however, are also acutely aware of the many roadblocks that stand in the way of TOD implementation.

To the degree BRT TOD takes root worldwide and delivers hoped-for benefits, such barriers might be expected to wane with time.

## 8. Conclusion

A fairly fundamental change in thinking about the role of large-scale infrastructure investments like BRT is needed, particularly among public officials and city leaders in the developing world. Notably, BRT should be conceived as more than mobility investments. They also present unprecedented opportunities for restructuring urban and regional growth in more sustainable formats. BRT can serve as a backbone for guiding growth in a more compact, mixed-use urban form—one that not only promotes transit riding and less driving, but also curbs sprawl and the significant costs associated with it.

The cases of Bogotá and Ahmedabad reveal that in the absence of proactive planning and attempts to entice private development near stations, few land-use changes occur. In both cases, long-range strategic planning and urban development objectives have been largely usurped by near-term engineering and cost-minimization objectives, resulting in lines being routed and stations sited in areas with minimal development potential. In truth, similar stories could have been told of BRT experiences in Bangkok, Jakarta, and many other rapidly growing cities facing political pressures to get systems built quickly and affordably.

Fortunately, there are good-case examples that showcase the positive impacts of proactively leveraging development opportunities from BRT investments. Curitiba's experiences are well-known and for the most part reveal the payoffs of linking good urban planning practice with BRT investments over multiple decades. Experiences in Seoul, South Korea reveal that in a crowded, congested, and land-constrained city, access improvements conferred by BRT prompt property owners and developers to intensify land uses along BRT corridors (Cervero and Kang, 2011). In Seoul, however, market forces were steered by pro-active planning that among other things created high-quality walking environments along BRT corridors. Several Chinese cities, notably Guangzhou, have designed high-quality connections to BRT stops, in contrast to places like Ahmedabad where, as reviewed above, pedestrian access was a secondary consideration. Guangzhou's BRT features seamless pedestrian connections through gently sloped footbridges and same-level integration with the second floors of adjoining commercial buildings. A network of green connectors ensures high-quality perpendicular connections for pedestrians and cyclists reaching stations from two or more blocks away. Owing to the combination of high-quality BRT services and pedestrian connections to stations, high-rise commercial development is gravitating to Guangzhou's BRT corridor, increasing real estate prices by 30 percent during the first two years of BRT operations (Suzuki et al., 2013). Pedestrian-friendly urban designs are critical not only to successful BRT in Chinese cities but also, according to recent research findings, to creating viable urban rail station areas as well (Mu and de Jong, 2012).

A number of significant barriers need to be overcome if future BRT investments are to significantly shape urban form in rapidly growing cities of the world. Among these will be the need to balance the current focus on short-term problem-solving with an ethos of forward-looking, strategic planning. The fragmented institutional structures for planning transportation systems and managing urban growth will also have to be revamped. Financial constraints also stand in the way of TOD. One way to overcome barriers and bring about change would be for international aid organizations and donor agencies to tie financial assistance for BRT projects to bona fide local efforts to improve the coordination and integration of transit and land development projects. Prodding local governments to introduce value-capture schemes would generate much-needed revenues to help jump-start TOD. As experiences in Hong Kong show, a virtuous cycle can be set into motion in which denser, high-quality TOD generates income which can go into creating future high-quality TODs, which further boost economic returns and so on (Cervero and Murakami, 2009).

As urban growth shifts to cities in the developing world, unprecedented opportunities exist for linking land development and transit infrastructure. Given that the vast majority of urban growth is projected for smaller and intermediate size cities, a bus-based form of TOD interlaced with high-quality infrastructure for pedestrians and cyclists can place many global cities on sustainable pathways. In contrast to large cities that tend to be fairly built out, smaller ones often are poised to experience considerable amounts of new growth in coming years, thus the opportunities for investing in affordable systems like BRT and using these investments to shape urban growth can be considerable. Many developing cities have the prerequisites needed for BRT investments to trigger meaningful land-use changes, including rapid growth, rising real incomes, and increased motorization and congestion levels. Supportive planning and zoning, public-sector leveraging and risk-sharing, attention to facility siting and design details to maximize development potential, and the institutional capacity to manage land-use shifts are also needed.

## Acknowledgements

Parts of this work was conducted under a project with World Bank in collaboration with Hiroaki Suzuki and Kanako Iuchi. Support for the Ahmedabad case was provided by the Centre of Excellence in Urban Transport, CEPT University, under H.M. Shivand Swamy. Support for the Bogotá case came from Geografia Urbana, led by Alejandro Rodriquez.

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