CHAPTER 2
Lessons from Sustainable Transit-Oriented Cities

Global experiences show that cities on sustainable pathways are able to successfully link public transit investments and urban development. This was a core message of the book, The Transit Metropolis: A Global Inquiry (Cervero 1998). This chapter builds upon that work, updating and extending half the cases from The Transit Metropolis. Several case cities were also added to highlight recent good practices in transit and land-use integration and to examine innovative land value capture financing methods.

Cities that have successfully integrated transit and urban development have done so in one of two ways. Adaptive cities altered their urban form—through higher densities and mixed land-use patterns, for example—to support what is inherently the most resourceful form of motorized mobility: high-capacity, high-quality transit services, such as metros and bus rapid transit (BRT). Other cities focused on adaptive transit, modifying transit in less traditional ways to allow it to better serve market-driven, largely low-density patterns of urban and suburban development.

This chapter first reviews the experiences of seven adaptive cities—cities that created a compact, mixed-use, walking-friendly built form that has enabled high-quality, high-capacity public transit services to thrive. The cities include two Scandinavian cities (Copenhagen and Stockholm); four Asian cities (Hong Kong SAR, China; Seoul; Singapore; and Tokyo); and one North American city (Washington, DC).

These seven cases are followed by a review of two cities with successful BRT systems, Curitiba, Brazil and Ottawa, Canada. Although Curitiba is included in this group, it has more attributes of an adaptive city (that is, high-rise, lineal patterns of development) than an automobile-centric city oriented to flexible, adaptive forms of transit. It is the common feature of BRT services that links this group. Because chapter 3 focuses on two BRT cities, Ahmedabad, India and Bogota, Colombia, the experiences of bus-based Curitiba and Ottawa are particularly germane to the themes of this book.
Most of the cases reviewed are from developed countries, whose experiences are not directly applicable or easily transferred to rapidly developing cities like Ahmedabad and Bogota. For this reason, the aim of this chapter is less to shape the precise practices of rapidly growing cities in developing countries, and more to impart key principles and lessons that can guide the planning and practices of cities currently planning for or investing in large-scale transit systems.

The cities reviewed differ immensely in geographic size, population, economic bases, socio-demographic makeup, and intensities of transit usage (see annex table 2A.1 for comparative background information on nine of these cities). They range from Denmark’s capital, Copenhagen, with a metropolitan population of about 1.2 million, to the world’s two largest megalopolises—metropolitan Tokyo and Seoul, each with more than 24 million inhabitants. The share of daily trips by transit ranges from 21 percent in Ottawa to more than 60 percent in Hong Kong SAR, China; Seoul, Republic of Korea; and Singapore. Such wide variation underscores the difficulties of generalizing and drawing lessons that are applicable to all settings and contexts. Clearly, creating sustainable cities of the future calls for adapting core lessons and insights gained from best-case practices to the political, cultural, and institutional realities of particular urban settings.

A signature feature of successful transit metropolises is that they are environmentally sustainable. Another is that compact urban forms are generally needed for high ridership levels, and thus positive environmental outcomes, to be attained. That is, mass transit needs mass. An increasingly critical argument is that transit-oriented sustainable urban forms are fully consistent with economic prosperity and productivity.

Global statistics, using some of the city-region cases in this report, shed light on these matters. The International Association of Public Transport (UITP) publishes the Mobility in Cities database, which provides background data on a number of international cities, including some of the case cities.

Vehicle kilometers traveled (VKT) per capita is widely viewed as the best aggregate metric for gauging sustainability in the urban transport sector. As VKT per capita increases, so does fossil fuel consumption; tailpipe emissions (for example, carbon dioxide [CO₂] and photochemical smog); and land consumption from roadway expansion. Figure 2.1 reveals a strong negative association between transit usage and VKT per capita. Cities such as Stockholm; Hong Kong SAR, China; and Curitiba, Brazil stand out for their comparatively small environmental footprints.

The positive association between population density and transit ridership is shown in figure 2.2. Although not sufficient, compact patterns of development are usually a necessary feature of a successful transit system, at least when measured on the basis of per capita transit ridership.

The ways in which relationships between transportation and urban form influence economic productivity have garnered increased policy attention in recent years. Some research finds that compact and highly accessible cities
Figure 2.1  Transit ridership and vehicle kilometers traveled per capita in selected global cities

Source: Authors, based on data from UITP 2006.
Note: VKT = vehicle kilometers traveled.

Figure 2.2  Population density and transit ridership in selected global cities

Source: Authors, based on data from UITP 2006.
are associated with relatively high levels of labor productivity (Prud’homme and Lee 1999; Cervero 2001, 2009). Well-designed cities and efficient pricing of infrastructure that helps slow VKT growth can also promote economic growth, studies reveal. A report by the Center for Clean Air Policy (2011), for example, finds that states in the United States with lower VKT per capita tend to have higher gross domestic product (GDP) per capita. Although correlations do not prove causality and other researchers have reached opposite conclusions (QuantEcon 2009), most observers agree that the aim should be less about encouraging physical movement and more about designing communities and pricing resources to maximize economic and social interactions.

For the global cities studied in the UITP database, low VKT and high transit ridership are at least not associated with low economic performance (table 2.1). European cities with world-class transit systems, such as Munich and Zurich, for example, have high average GDP per capita, high transit ridership, and relatively modest VKT per capita. Zurich is one of the wealthiest cities in the world, ranking first in 2011, according to the City Mayor’s database. Its high per capita level of transit ridership is matched by commercial real estate values that are among the highest in the world; its quality of life is rated the highest in the world (Mercer 2002); it has one of the lowest vehicle ownership rates in the developed world (40 percent of households have no cars); and its air quality is among the best of any European city (Cervero 1998; Mees 2009).

<table>
<thead>
<tr>
<th>City</th>
<th>Transit trips/person/year</th>
<th>Vehicle kilometers traveled/person/year</th>
<th>GDP per capita ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hong Kong SAR, China</td>
<td>627</td>
<td>4,880</td>
<td>27,600</td>
</tr>
<tr>
<td>Munich, Germany</td>
<td>534</td>
<td>9,670</td>
<td>45,800</td>
</tr>
<tr>
<td>Zurich, Switzerland</td>
<td>533</td>
<td>8,690</td>
<td>41,600</td>
</tr>
<tr>
<td>Singapore</td>
<td>484</td>
<td>9,240</td>
<td>28,900</td>
</tr>
<tr>
<td>Stockholm, Sweden</td>
<td>346</td>
<td>7,210</td>
<td>32,700</td>
</tr>
<tr>
<td>Curitiba, Brazil</td>
<td>334</td>
<td>7,900</td>
<td>6,800</td>
</tr>
<tr>
<td>Copenhagen, Denmark</td>
<td>268</td>
<td>8,700</td>
<td>34,100</td>
</tr>
<tr>
<td>Melbourne, Australia</td>
<td>105</td>
<td>11,400</td>
<td>22,800</td>
</tr>
<tr>
<td>Chicago, United States</td>
<td>73</td>
<td>12,000</td>
<td>40,000</td>
</tr>
</tbody>
</table>

Source: Authors, based on data from UITP 2006.

Transit and Land-Use Integration in Adaptive Cities

This section reviews experiences in seven adaptive cities: Copenhagen; Stockholm; Hong Kong SAR, China; Seoul; Singapore; Tokyo; and the Washington, DC metropolitan area, where metrorail investments were used
Lessons from Sustainable Transit-Oriented Cities

Copenhagen: Transit Oriented and Bike Friendly

A textbook example of long-range planning visions shaping rail investments, which in turn shaped urban growth, comes from Copenhagen, with its celebrated “finger plan.” Early in the planning process, planners identified corridors for channeling overspill growth from the urban centers. Rail infrastructure was built, often in advance of demand, to steer growth along desired growth axes. Greenbelt wedges set aside as agricultural preserves, open space, and natural habitats were designated and major infrastructure directed away from districts with these features. The evolution of Copenhagen—from a finger plan to a directed rail-investment program along defined growth axes to a finger-like urbanization patterns—is shown in figure 2.3.

On the periphery of Copenhagen are new towns that are bike and pedestrian friendly. Suburban towns of 10,000–30,000 inhabitants, like Ballerup, Brønby, and Høje-Taastrup, are laced by greenways that connect neighborhoods, schools, retail centers, and pocket parks to inviting rail stops. About half of residents in these middle-class, master-planned new towns take a train to work, and four out of five walk, bike, or take a bus to their community’s rail station.

Copenhagen planners have long embraced the notion that industrial progress should not encroach on the rights and needs of pedestrians and cyclists. They created one of the first and the longest car-free streets in Europe, Strøget, which, during summer, accommodates some 55,000 pedestrians, often shoulder to shoulder. Street life is not viewed only in terms of foot

Figure 2.3  Evolution of Copenhagen’s “transit first” plan

Source: Cervero 1998; reproduced with permission from Island Press, Washington, DC.
traffic but also with regard to stationary activities. Jan Gehl, a noted urban designer from Copenhagen, sold city leaders on the idea that great public spaces accommodate not only busy pedestrians but also casual sitting, relaxing, and milling about. Today, some 80,000 square meters of public squares—big and small, grand and modest—dot central Copenhagen.

One of the chief ways of meeting the needs of cyclists has been the expropriation of car lanes and curbside parking for their exclusive use. Between 1980 and 2005, Copenhagen’s inventory of bike lanes increased from 210 to 410 kilometers within an area of about 90 square kilometers. Over the same period, the number of bike trips rose 80 percent. By 2005, 36 percent of journeys to work in Copenhagen were by bicycle, the highest mode split of any capital city in Europe. The city’s master plan, Eco-Metropolis for 2015, commits Copenhagen to become “the world’s best city for bicycling” (City of Copenhagen 2008). Copenhagen has set an ambitious goal of 50 percent of its citizens biking to work or school by 2015. New, separated cycle-tracks are being added in hopes of achieving this goal.

To further boost cycling, Copenhagen introduced a short-term bike lease program, called City Bikes, in 1995. More than 2,000 white bikes have been placed at some 140 bike stands throughout the city. In addition to improving rail access, the program reduced on-vehicle carriage of bikes, freeing up train capacity for passengers. City Bikes is overseen by a local nonprofit organization that hires hundreds of “rehabilitees” (prisoners who are being rehabilitated) to maintain the bikes. The organization reports that 55 percent of the rehabilitees get jobs after participating in the program (Foundation City Bikes 2009). Statistics reveal how well articulated Copenhagen’s “access shed” is for transit riding. A 2002 survey of 15 suburban rail stations found that people walked 38–100 percent of access trips up to 1 kilometer; for trips 1–2 kilometers away, cycling accounted for 40 percent of access trips. Beyond 2 kilometers, buses handled two-thirds of access trips. Even 4 kilometers from stations, twice as many access trips were by bicycle as by car. Danish designers have found that acceptable walking and cycling distances can be stretched considerably by creating attractive, visually stimulating, and safe travel corridors. Partly by doing so, Copenhagen succeeded in reducing CO₂ emissions per capita by 25 percent between 1990 and 2008 (City of Copenhagen 2010).

A transit-oriented built form that is pedestrian and bike friendly is not the only factor accounting for Copenhagen’s low annual VKT per capita of 8,700 (see table 2.1). Also critical have been national policies that aim to moderate car ownership and usage. Every four years since World War II, the national government has issued policy guidelines aimed at shaping the land-constrained country’s physical development. Over the years, a series of national directives have called for targeting Greater Copenhagen’s future growth around rail transit stations. National infrastructure funds are tied to compliance with these directives. Although they do not carry the force of law, Denmark’s national directives clearly imply that localities are to make
good faith efforts in encouraging transit-oriented development (TOD). The nation’s Ministry of Environment has veto power over proposed local development projects. These veto powers have been exercised sparingly over the years, in large part because most localities strongly support sustainable patterns of development.

In addition to national directives that mandate that major trip generators be sited near rail stops, Denmark adds taxes and fees that typically triple the retail price of a new car. At 250 motor vehicles per 1,000 inhabitants, Copenhagen’s vehicle ratio is about half that of large German cities like Hamburg and Frankfurt.

Local policies also restrict car travel. Central-city road capacity in Copenhagen has been kept constant since 1970; outside the core city, additional road capacity must be matched by at least as many square meters of additional bike lanes and bus lanes. Parking has also been restricted, particularly near rail stops. The outsourcing of parking to peripheral areas has led to a 2–3 percent annual reduction in core-area parking. Central-city bus services have been enhanced by a system of reserved lanes and signal prioritization.

Also strengthening Copenhagen’s standing as a transit metropolis has been the expansion of rail services. The city has built new rail “fingers,” notably, an automated, fully grade-separated line to the new-town of Orestad, south of the center city (figure 2.4).

Rail services preceded development in Orestad, a clear case of building transit first to guide development. From the start, Orestad was a true mixed-use community, designed as a place to live, work, shop, learn, and play. Particular attention was paid to the livability of the new community. Housing was built close to parks and canals and connected by plazas and pathways. Cafes and squares were sited to attract customers who arrive by foot. Neighborhood parks were designed to meet the diverse recreational needs of residents. In contrast to the drab, standardized appearance of Copenhagen’s early-generation TODs, Orestad also features a variety of architectural styles carefully planned to interact and blend with one another. Many of Orestad’s signature buildings were designed by world-class architects, and several have won prestigious design awards. Orestad’s diversity is underscored by one of the largest car-free housing developments anywhere, called Urbanplanen.

Another rail line being built in the region follows a circular route, providing “cross-finger” connections. This Cityringen metro line will serve a number of districts outside the city proper not served by the S-Train commuter rail system. The sale of land whose value has appreciated in anticipation of new rail services has helped finance new investments like Cityringen, the Orestad line, and Copenhagen’s first light rail line, Letbanen, being built parallel to the region’s third ring road.

Copenhagen planners have also taken advantage of new technologies to enhance the transit riding experience. In 2009, the city introduced a
new state-of-the-art mobile ticket for transit trips. Customers are now able to buy and display tickets on their mobile phones for transit rides on the metro, suburban commuter rail lines, and city buses.

**Stockholm: First-Generation Transit Necklace, Second-Generation Urban Regeneration**

The last half century of strategic regional planning has given rise to regional settlement and commuting patterns in Greater Stockholm that have substantially reduced dependency on automobiles in middle-income suburbs. Stockholm’s investment in radial rail lines has given rise to a “string of pearls” urban form and a balanced use of land for work and housing. By consciously establishing a balance between jobs and housing along rail-served axial corridors, Stockholm planners produced directional flow balances in commuting periods. 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 mode share is nearly twice that found in larger rail-served European cities, such as Berlin; it is even higher than inner London’s...
market share. Perhaps most impressive, Stockholm is one of the few places where automobile use appears to be receding. Between 1980 and 1990, Stockholm was the only city among a sample of 37 cities that registered a per capita decline in automobile use—a drop of 229 annual kilometers of travel per person (Kenworthy and Laube 1999). Its VKT per capita remains among the lowest in the world (see table 2.1). An independent analysis by Siemens AG/McKinsey (2008) finds Stockholm’s per capita CO$_2$ emissions from transportation lower than four other rail-served and considerably larger global cities (London, New York, Rome, and Tokyo).

These statistics do not mean that Stockholm is “anti car.” In fact, Stockholm has a relatively high level of car ownership (555 cars per 1,000 inhabitants) (European Commission 2012). In a well-designed transit metropolis like Stockholm, residents simply drive less; they are more judicious and discriminate in their use of the cars more than car owners in other cities. Most Stockholmers use public transport to get to work, selectively using cars where they have natural advantages, such as for grocery shopping or weekend excursions.

Stockholm is credited with spearheading TOD in the age of the motorway, in the form of master plans for new towns like Vällingby, where the rail stop sits squarely in the town center. Upon exiting the station, passengers step into a car-free public square surrounded by shops, restaurants, schools, and community facilities. The civic square, adorned with benches, water fountains, and greenery, is the community’s central gathering spot—a place to relax, socialize, and hold special events, such as public celebrations, parades, and demonstrations. Sometimes the square doubles as a place for farmers to sell their produce or street artists to perform, changing chameleon-like from an open-air market one day to a concert venue the next. The assortment of flower stalls, sidewalk cafes, newsstands, and outdoor vendors dotting the square, combined with the musings and conversations of residents sitting in the square, retirees playing chess, and everyday encounters among friends, adds color and breathes life into the community. A community’s rail station and its surroundings are thus more than a jumping off point to catch a train—they should also be the kinds of places people are naturally drawn to. If done well, TODs are “places to be,” not “places to pass through” (Bertolini and Spit 1998).

Development of Hammarby Sjöstad. The first generation of TOD in metropolitan Stockholm was on former greenfields, such as Vällingby and Kista. More recently, a push has been made to redevelop brownfields. The most notable example is Hammarby Sjöstad, an eco-community that has taken form along a recently built inner-ring tramway.

The development of Hammarby Sjöstad marked an abrupt shift in Stockholm’s urban planning practice. For decades, new towns had been built on peripheral greenfield sites. Hammarby Sjöstad is one of several “new-towns/in-towns” created based on Stockholm’s 1999 city plan, which set forth a vision of “building the city inward.”
Consisting of some 160 hectares of brownfield redevelopment, Hammarby Sjöstad stands as Stockholm’s largest urban regeneration project to date. Because the project focuses on a new inner-city transit line and is designed for energy self-sufficiency and minimal waste, it has been called a “green TOD” (Cervero and Sullivan 2011). Just as the greenfield town of Vällingby pioneered TOD, Hammarby Sjöstad is a paragon of TOD with green urbanism and green architecture (table 2.2).

The community’s signature transit element is a new tramway, Tvärbanan, which runs through the heart of the community along a 3-kilometer boulevard (Hammarby Allé and Lugnets Allé). In TOD fashion, taller buildings (mostly six to eight stories) cluster along the transit spine, and building heights taper with distance from the rail-served corridor. Trams run every seven minutes in peak hours and provide five-minute connections to Stockholm’s metro underground network and commuter trains. Rail stations are well designed and fully weather protected, and they provide real-time arrival information. The city’s buses run on biogas produced by local wastewater processing.

Parks, walkways, and green spaces are also prominent throughout Hammarby Sjöstad. Where possible, the natural landscape has been preserved. Bike lanes run along major boulevards, ample bike parking can be found at every building, and bike and pedestrian bridges cross waterways. Design features that are integral to TOD, like buildings that go up to the sidewalk line (that is, no set-backs), offer comfortable and secure walking corridors with clear sight lines. They also bring destinations together and, by creating side friction (parallel movements that prompt vehicles to slow down and encourage pedestrian activities), slow traffic.

The presence of three car-sharing companies, which together provide access to 37 low-emission vehicles, has further reduced the need to own a car in Hammarby Sjöstad. The area was designed with just 0.25 parking spaces per dwelling unit (though this rate has inched up some in recent years). All commercial parking is for a fee, and rates discourage long-term parking. The neighborhood sits just outside Stockholm’s congestion toll boundary, adding another incentive to use public transport, walk, or bike when heading to the central city.

Hammarby Sjöstad’s green urbanism is found in energy production, waste and water management, and building designs. The annual energy use of buildings in Hammarby Sjöstad is set at 60 kilowatt hours, a third less than for the city as a whole. All windows are triple-glazed and walls thoroughly insulated. Other conservation measures include extra heat insulation, energy-efficient windows, on-demand ventilation, individual metering of heating and hot water in apartments, electrically efficient installations, lighting control, solar panels, fuel cells, reduced water flow, and low-flush toilets.

The ecological feature of Hammarby Sjöstad that has garnered the most attention is the fully integrated closed-loop eco-cycle model. This clever system recycles waste and maximizes the reuse of waste energy and materials for heating, transportation, cooking, and electricity.
Also impressive is the community’s approach to water management. All storm water, rainwater, and snowmelt is collected; purified locally through sand fiber, stormwater basins, and green roofs; and released in purified form into a lake. A preserved oak forest, ample green surfaces, and planted trees help collect rainwater to ensure cleaner air and provide a counterbalance to the dense urban landscape.

Hammarby Sjöstad is well on its way to becoming a low-carbon eco-community. Relative to conventional development, the project reduced air, soil, and water emissions and pollution by 40–46 percent; nonrenewable energy use by 30–47 percent; and water consumption by 41–46 percent (Cervero and Sullivan 2011). Similar to the rest of Stockholm, 95 percent of all waste produced by Hammarby Sjöstad’s household is reclaimed.

<table>
<thead>
<tr>
<th>Built environment</th>
<th>Green transportation</th>
<th>Green urbanism</th>
<th>Open space, water, and stormwater</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brownfield Infill</td>
<td>“Tvärbanan” light rail line: 3 stops in district:</td>
<td>Waste converted to energy:</td>
<td>Stormwater treatment:</td>
</tr>
<tr>
<td>Former army barracks:</td>
<td>• 5 minutes to major station</td>
<td>• Food waste and wastewater sludge converted to biogas and used for heating</td>
<td>• Rainwater collection</td>
</tr>
<tr>
<td>• High density along light rail boulevard (8 stories)</td>
<td>• 10–30 minutes to all parts of Center City</td>
<td>• Combustible waste burned for energy and heat</td>
<td>• Maximum permeable surfaces</td>
</tr>
<tr>
<td>• TOD: Mixed use with ground-floor retail and a wide range of goods and services</td>
<td>• 7-min peak headway</td>
<td>• Paper recycled</td>
<td>• Purify runoff through soil filtration</td>
</tr>
<tr>
<td></td>
<td>2 bus lines Ferry Bike lanes and pedestrian bridges Ample bike parking at every building Car-sharing for 3 companies, 37 vehicles Near congestion toll boundary Pedestrian-friendly design/ complete streets</td>
<td>Heat recaptured for reuse Combined heat and power plant Low-energy construction and energy saving measures:</td>
<td>Ample open space:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Efficient appliances</td>
<td>• Inner courtyards</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Maximum insulation and triple-glazed windows</td>
<td>• Parks</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Playgrounds</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Green median</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Borders large nature reserve with ski slopes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Preservation of existing trees and open space</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Reduced water flow faucets and low-flush toilets</td>
</tr>
</tbody>
</table>

**Table 2.2 Green transit-oriented development attributes of Hammarby Sjöstad, Sweden**

*Source: Cervero and Sullivan 2011.*
Environmental benefits have accrued from Hammarby Sjöstad’s relatively high share of nonmotorized (walking and bicycling) trips. In 2002, the project’s mode splits were public transit 52 percent, walking/cycling 27 percent, and private cars 21 percent (table 2.3)—a much more ecological split than in suburban neighborhoods of Stockholm with similar incomes (Grontmij 2008). Noncar travel shares are thought to be considerably higher today. Car ownership has also fallen, from 66 percent of households in 2005 to 62 percent in 2007, in line with averages for the denser, core part of Stockholm (Grontmij 2008). Residents’ carbon footprint from transportation in 2002 was considerably lower than comparison communities (438 versus 913 kilograms of CO$_2$ equivalent/apartment/year) (Grontmij 2008). Stockholm’s goal is to become fossil fuel free by 2050.

Another barometer of Hammarby Sjöstad’s environmental benefits is the community’s relatively healthy local economy. Median household income was higher and the unemployment rate lower than the city of Stockholm as a whole in 2006, and land prices and rents have risen more rapidly over the past decade than most other parts of the Stockholm region (Grontmij 2008).

Transport demand management and pedestrian- and transit-oriented projects. Congestion pricing is an important component of creating a functional and livable core city. Stockholm’s electronic road pricing (ERP) scheme, introduced in 2004 on a trial basis, charges motorists for entering the central city on weekdays, using a graduated price scheme. Buses, taxis, eco-fuel cars, and drivers coming and going from the isolated island of Lidingo are exempted.

As traffic conditions and the quality of public transit services improved, citizens’ support grew steadily (Eliasson and others 2009). In a referendum in 2007, 53 percent of Stockholm residents voted to make the road pricing trial permanent. During the first two years of the permanent scheme, peak-period traffic volumes within the pricing zone fell 25 percent (removing 1 million vehicles from the road a day), CO$_2$ emissions fell 14 percent, and daily toll revenues reached about $300,000 (Eliasson and others 2009).

### Table 2.3 Mode splits for journeys in various parts of Stockholm County (percent)

<table>
<thead>
<tr>
<th>Mode of transportation</th>
<th>Inner city</th>
<th>Southern suburbs</th>
<th>Western suburbs</th>
<th>Hammarby Sjöstad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car</td>
<td>17</td>
<td>39</td>
<td>43</td>
<td>21</td>
</tr>
<tr>
<td>Public transit</td>
<td>36</td>
<td>28</td>
<td>23</td>
<td>52</td>
</tr>
<tr>
<td>Bike/walk</td>
<td>47</td>
<td>32</td>
<td>34</td>
<td>27</td>
</tr>
</tbody>
</table>

*Source: Authors, based on data from Grontmij 2008.*
Some revenues from congestion tolls have gone to enhance transit services; most have been used to upgrade road facilities, including the South City tunnel project (Sodra Lanken), which removes through-traffic from central-city surface streets, and a western bypass project. Revenues are also going toward a major inner-city land reclamation project in the Slussen area. Guided by a master plan by noted architect Norman Foster, Slussen—which has been called a tangled mass of highway overpasses—is to become a pedestrian- and transit-oriented central-city infill project. Slussen will feature attractive public spaces and water terraces that link pedestrians on a historic route into the old city.

Also in the works are makeovers of Stockholm’s first-generation transit villages. Välingby’s upgrading is being called one of Sweden’s largest suburban renewal projects. Skarholmen, Spanga, and Kista Science City are also being renovated as second-generation TODs.

Hong Kong SAR, China: Profitable Transit

Any visitor to Hong Kong SAR, China, instantly recognizes that public transit is the lifeblood of the city. The city boasts a wide array of transit services, including a high-capacity railway network, surface-street trams, ferries, and an assortment of buses and minibuses. In late 2007, the city’s main passenger rail operator, Mass Transit Railway Corporation (MTRC), merged with the former Kowloon-Canton Railway Corporation, forming a 168-kilometer network of high-capacity, grade-separated services on the island of Hong Kong; the Kowloon peninsula; the Northern Territories (to the Chinese border); and, through a recent extension, to the new international airport. In 2000, more than 90 percent of all motorized trips were by public transit, the highest market share in the world (Lam and Bell 2003; Cervero and Murakami 2009).

The combination of high urban densities and high-quality public transit services has not only produced one of the highest levels of transit usage in the world (570 annual public transport trips per capita), it has also substantially driven down the cost of motorized travel. In 2002, more than half of all motorized trips made by city residents were half an hour or less (ARUP 2003). Motorized travel consumes, on average, about 5 percent of the city’s GDP. This figure contrasts sharply with more automobile-oriented global cities, such as Houston, Texas, and Melbourne, Australia, where more than one-seventh of GDP goes to transportation (IAPT 2002). Hong Kong SAR, China residents enjoy substantial travel cost savings even in comparison with much larger global cities with extensive railway networks, like London and Paris.

Hong Kong SAR, China is one of the few places in the world where public transit makes a profit. It does so because the city’s rail operator, MTRC, has adopted the “Rail+Property” (R+P) program (Cervero and Murakami 2009). R+P is one of the best examples anywhere of transit value capture in action. Given the high premium placed on access to fast, efficient, and
reliable public transit services in a dense, congested city, the price of land near railway stations is generally higher than elsewhere, sometimes by several orders of magnitude. MTRC has used its ability to purchase the development rights for the land around stations to recoup the cost of investing in rail transit and turn a profit. The railway has also played a vital city-shaping role. In 2002, about 2.8 million people, 41 percent of the population, lived within 500 meters of a railway station (Tang and others 2004).

The profit motive accounts for MTRC’s active involvement in land development. As a private corporation that sells equity shares on the Hong Kong stock market, MTRC operates on commercial principles, financing and operating railway services that are self-supporting and yield a net return on investment. The full costs of public transit investments, operations, and maintenance are covered by supplementing fare and other revenues with income from ancillary real estate development, such as the sale of development rights, joint ventures with private real estate developers, and the operation of retail outlets in and around subway stations. The local government is MTRC’s majority stockholder, ensuring that the company weighs the broader public interest in its day-to-day decisions. At the same time, the ownership of 23 percent of MTRC’s shares by private investors exerts market discipline, prompting the company to be entrepreneurial.

Between 2001 and 2005, property development produced 52 percent of MTRC’s revenues. By contrast, railway income, made up mostly of fare-box receipts, generated 28 percent of total income. MTRC’s involvement in all property-related activities—development, investment, and management—produced 62 percent of total income, more than twice as much as fares. An example of an R+P project that has yielded both high rates of financial returns and high ridership (and thus fare-box income) is Maritime Square at the Tsing Yi Station (figure 2.5).

Timing is crucial in MTRC’s recapturing of the value added by rail service. MTRC purchases development rights from the local government at a “before rail” price and sells these rights to a selected developer (among a list of qualified bidders) at an “after rail” price. The difference between land values with and without rail services is substantial, easily covering the cost of railway investments. When bargaining with developers, MTRC also negotiates a share of future property development profits or a co-ownership position from the highest bidder. Thus, MTRC receives a “front end” payment for land and a “back end” share of revenues and assets in kind.

MTRC has hardly been the sole financial beneficiary of R+P. Society at large has also reaped substantial rewards. Between 1980 and 2005, it is estimated that Hong Kong SAR, China received nearly $140 billion (in current dollars) in net financial returns. This estimate is based on the difference between earned income ($171.8 billion from land premiums, market capitalization, shareholder cash dividends, and initial public offer proceeds) and the value of injected equity capital ($32.2 billion from land grants). Thus, the government has enjoyed huge financial returns and seeded the
Lessons from Sustainable Transit-Oriented Cities

The construction of a world-class railway network without having to advance any cash to MTRC. Moreover, the $140 billion figure is only the direct financial benefit. The indirect benefits—for example, reduced sprawl, air pollution, and energy consumption and higher ridership through increased densities—have increased net societal returns well beyond $140 billion.

Hong Kong SAR, China has long had tall towers perched above railway stations. But density alone does not make a good TOD. Often missing was a high-quality pedestrian environment and a sense of place. Most first-generation R+P projects featured indistinguishable apartment towers that funneled pedestrians onto busy streets and left them to their own devices to find a subway entrance. Growing discontent over sterile station-area environments and older buildings’ sagging real estate market performance...
prompted MTRC to pay more attention to principles of good town planning and urban design.

In 2000, MTRC created a town planning division within the corporation to pursue land development strategies that met corporate financial objectives while also enhancing station-area environments. Before 2000, R+P projects followed the existing development pattern rather than anticipated development; yet, with an in-house town planning department, MTRC became more proactive. The company is now ahead of market demand, building high-quality, pedestrian-friendly TODs to steer growth. Research shows that the design of high-quality walking environments has increased financial returns per square meter for R+P projects (Cervero and Murakami 2009). Pedestrian-friendly R+P projects have contributed to sustainable urbanism as well as sustainable finance, as these benefits have been capitalized into land prices.

Seoul: Bus Rapid Transit and Urban Land Reclamation

At the turn of the 21st century, Seoul embarked on a bold experiment in urban regeneration, principally involving the reclamation of urban space given to the automobile in the post–Korean War era. Through the leadership of Myung-Bak Lee, the former mayor of Seoul and the current president of the Republic of Korea, the city has sought to strike a balance between transit infrastructure as a provider of mobility and public space as an urban amenity. In good part, this effort has been prompted by the desire to make Seoul globally competitive with the likes of Hong Kong SAR, China, Shanghai, and other East Asian heavyweights of by emphasizing quality of life every bit as much as mobility and large-scale infrastructure development.

Like many modern metropolises in East Asia, over the past several decades Seoul has followed a pattern of American-style sprawl, fueled by steady economic growth and the concomitant meteoric rise in private automobile ownership. However, population densities in Seoul (10.4 million inhabitants spread over a land area of 605 square kilometers) have historically been and remain high by global standards. The city of Seoul itself, along with the port city of Incheon and surrounding Kyunggi Province, constitute the Seoul Metropolitan Area (also called the Seoul National Capital Area), with more than 23 million inhabitants—the world’s second-largest urban agglomeration. In 2006, Seoul and Incheon combined had the sixth-highest population density in the world (16,700 people per square kilometers). Because of such high densities, the Seoul metropolitan government has over the years aggressively sought to decentralize growth, mainly in the form of building master-planned new towns sited on the region’s periphery.

A severe housing shortage and rising housing rents (fueled largely by land speculation) during the 1980s prompted the Korean government to build new towns quickly, as a mass-produced commodity. Twenty-six new towns have been built in the greater Seoul Metropolitan Area over the past three decades. Most were built in a modernist Le Corbusier style, as mid- to high-rise “towers in the park.”
The shortage of central-city land combined with the presence of a protective greenbelt that surrounds the city of Seoul resulted in most new towns being built in the region’s far-flung fringes (Jun and Hur 2001).

New-town development achieved its goal of stabilizing housing prices, but it did so at a price: congestion on radial links to the urban center worsened, tailpipe emissions and fuel consumption rose, and demand for expensive highway infrastructure mushroomed. Between 1990 and 1996, the average commuting distance of new-town residents increased 70 percent (Jun 2000). Longer trips combined with increased car ownership inevitably translated into steadily worsening traffic congestion: average speeds during evening hours in the Seoul Metropolitan Area fell from 24 kilometers an hour in 1998 to 17 kilometers an hour in 2003. Daily commuting expenses rose sharply, as well: one study estimated the out-of-pocket cost (ignoring the value of time and externalities) incurred by new-town residents living outside of Seoul’s greenbelt at $12 a day (Jun and Bae 2000).

By the late 1990s, rumblings could be heard within public policy circles that the region’s new towns were a failed experiment, exacerbating traffic congestion and reducing environmental quality. Some feared that such factors, along with the productivity losses from long commutes, were becoming a drag on economic growth, prompting companies and their workers to relocate elsewhere in the country and possibly even abroad. The idea of reurbanizing Seoul’s central areas through “new-towns/in-towns” began to surface.

Myung-Bak Lee led the charge of reinvesting in the central city and regenerating Seoul. In 2001, Lee ran for mayor of Seoul, largely on a platform of reinvigorating the central city as means of creating a more sustainable yet productive city. Lee campaigned on the premise that Seoul could achieve a better balance between function and the environment by reordering public priorities so as to emphasize quality of place. Before becoming mayor, Lee found and led the Hyundai Group for three decades, Korea’s largest builder of public works and infrastructure projects, including highways.

Lee won a decisive victory. Upon assuming office, in early 2002, he moved quickly on his campaign promises. His vision called not only for expanding public transit services but also for reducing the ecological footprint of private cars by reclaiming urban space consumed by roads and highways, especially space used to funnel new-town inhabitants in and out of the central city. Why scar the interior of the city, he reasoned, to funnel suburbanites to office jobs in the core? A major culprit was the network of elevated freeways that converged on central Seoul—facilities that severed longstanding neighborhoods, formed barriers and created visual blight, cast shadows, and sprayed noise, fumes, and vibrations on surrounding areas. Although freeways provided important mobility benefits, Lee recognized that those benefits had to be weighed against their nuisance effects, particularly in today’s amenity-conscious workplace.
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The removal of a six-kilometer elevated freeway in the heart of Seoul, Cheong Gye Cheon (CGC), and the restoration of an urban stream and pedestrian-friendly greenway was a natural choice to launch Lee’s vision of a more sustainable urban landscape for the city. Change was swift. By February 2003, a plan for the freeway removal was completed; five months later, the freeway had been completely dismantled. Some two years later, in September 2005, the restored CGC stream and linear greenway was opened to the public, following a major public celebration and ribbon cutting by Mayor Lee (figure 2.6). The entire cost of the freeway demolition and stream restoration was $313 million.

Equally important in symbolic terms was the mayor’s decision to convert a massive 1.3 hectare surface-street intersection to an oval-shaped grass park in front of Seoul’s City Hall, the nerve center of the city. The huge swath of real estate devoted to car maneuvers in front of City Hall, an architectural icon and one of the busiest locations in the city, created an extremely pedestrian-hostile environment. Today, the green oval is one of the city’s most popular gathering places.

Mayor Lee made his policy intentions clear when publicly stating that the transformation of space for cars to space for people represented “a new paradigm for urban management in the new century” (Seoul Metropolitan Government 2003, p. 1). His views were partly shaped by what was happening in several Latin American cities at the time, especially Curitiba, Brazil, which he visited at the invitation of Jaime Lerner, former mayor of Curitiba. Mayor Lee defended the roadway removal projects on the grounds that “we want to make a city where people come first, not cars.” The diminution of roadway capacity represents, in many ways, a recasting of public priorities. In Seoul’s case, it marked a shift from building infrastructure that

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**Figure 2.6** Transformation of Seoul’s Cheong Gye Cheon from an elevated freeway to an urban greenway

*a. Elevated freeway*  
*b. Urban greenway*

*Source: Seoul Metropolitan Government 2003.*
enhances automobility to infrastructure that enhances public amenities and the quality of urban living. A longer-term objective was to encourage more households to settle in the central city and in redevelopment districts, thus reversing the centrifugal flow of residents to Seoul’s outskirts and beyond—in effect, creating a new form of urban development.

In and of itself, the withdrawal of road capacity in an increasingly automobile-dependent society will do little to enhance the quality of urban living. Mayor Lee understood that public transit had to be substantially expanded and upgraded to absorb the traffic (169,000 cars a day on the CGC freeway) displaced by large-scale reductions in roadway capacity. The city did so partly by extending subway lines. More important was the 2004 opening of seven new lines of exclusive median-lane buses (stretching 84 kilometers, later expanded to 162 kilometers) and 294 kilometers of dedicated curbside bus lanes. Figure 2.7 shows the staged expansion of BRT services in Seoul.

Figure 2.7  Bus rapid transit corridors in central Seoul

Source: Cervero and Kang 2011.
Seoul’s BRT investments have paid off handsomely. Bus operating speeds have increased from an average of 11 kilometers to more than 21 kilometers per hour, and speeds have increased in some passenger-car lanes (table 2.4). BRT buses, moreover, carry more than six times as many passengers per hour as buses operating on regular mixed-traffic lanes. And because they are less subject to the vagaries of ambient traffic flows, buses operating in dedicated lanes have become more reliable: the travel-time variation of Seoul’s BRT buses is, on average, five times less than that of buses operating on nonexclusive lanes (Seoul Development Institute 2005). Protected lanes have also reduced the number of accidents, which declined 27 percent one year after BRT services were introduced. Because of these service enhancements and safety improvements, ridership on BRT buses increased 60 percent faster than on non–BRT buses between 2004 and 2005.

BRT was just one of several transit transformations introduced in Seoul. In the early 2000s, skyrocketing operating deficits prompted the metropolitan government to create a semipublic transit organization that set and enforced rules and standards on bus routes, schedules, and private operating practices. Many routes were reorganized into a timed-transfer and pulse-scheduling arrangement. All bus services were classified into one of four types of services: red (long-distance and intercity services), blue (trunk services), green (feeder services), and yellow (circular services). Red long-distance intercity lines link satellite cities with one another and downtown Seoul. Blue trunk lines connect the subcore and central-city Seoul. Green feeder buses mainly funnel passengers to subway stations and express bus stops. Yellow circular lines orbit the urban core.

Also introduced at the time of land reclamation was a sophisticated smart fare card that has allowed for efficient distance-based pricing and integrated bus-rail fares. A real-time traffic information system with message boards and in-vehicle navigation aids was installed to guide traffic flows and alert motorists to downstream hot spots. Curbside parking was substantially curtailed to help expedite traffic flows. More draconian was the introduction of a scheme that requires motorists to leave their cars at home once every 10 days (based on the last number of their license plate).

Land market responses to the BRT investments as well as projects like the CGC freeway-to-greenway conversion suggest that the net impacts have been positive (Kang and Cervero 2009; Cervero and Kang 2011). In a crowded, congested, and land-constrained city like Seoul, increased accessibility prompted property owners and developers to intensify land uses along BRT corridors, mainly by converting single-family residences to multifamily units, apartments, and mixed-use projects.

Land markets capitalized these accessibility gains, particularly in parcels used for condominiums and higher-density residential uses. Land price premiums of about 5–10 percent have been recorded for residences within 300 meters of BRT stops (Cervero and Kang 2011). For retail shops and other nonresidential uses, premiums were more varied, ranging from 3
percent to 26 percent over a smaller impact zone of 150 meters from the nearest BRT stop.

Greenways supported by expanded transit services further boosted land prices and development activities along high-amenity corridors. Housing prices within 3 kilometers of the elevated freeway fell, reflecting a disamenity; once the corridor was transformed to a greenway, prices of homes within 2 kilometers rose as much as 8 percent (Kang and Cervero 2009) (figure 2.8).

Commercial parcels also increased following the freeway-to-greenway conversion, as did the concentration of high-value-added industries that hire white-collar professionals and “creative class” workers (Kang and Cervero 2009). Given these changes in prices, one could argue that residents of Seoul valued the quality of the urban space more highly than a freeway. Quality of place won out over automobility as a desirable urban attribute.

In addition to the attractions of greenery and open space, part of the land-value gains conferred by the freeway-to-greenway conversion likely also reflected indirect environmental benefits. Air pollution levels along the CGC corridor have fallen since the stream restoration and greenway conversion. Concentrations of fine-grained particulate matter (PM$_{10}$) along the corridor were 13 percent higher than Seoul’s regional average before the conversion; after the conversion, they were 4 percent below the region’s average (Seoul Development Institute 2005). Concentrations of nitrogen dioxide (NO$_{2}$), a precursor to the formation of photochemical smog, fell from 2 percent above the regional average when the freeway was in operation to 17 percent below the regional average after the greenway was in place.

<table>
<thead>
<tr>
<th>Road</th>
<th>Before (June 2004)</th>
<th>After (August 2004)</th>
<th>Percentage change</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus (exclusive lane)</td>
<td>11.0</td>
<td>20.3</td>
<td>85.0</td>
</tr>
<tr>
<td>Car (other lane)</td>
<td>18.5</td>
<td>19.9</td>
<td>7.6</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus (exclusive lane)</td>
<td>13.1</td>
<td>22.5</td>
<td>72.0</td>
</tr>
<tr>
<td>Car (other lane)</td>
<td>20.3</td>
<td>21.0</td>
<td>3.4</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus (exclusive lane)</td>
<td>13.0</td>
<td>17.2</td>
<td>32.0</td>
</tr>
<tr>
<td>Car (other lane)</td>
<td>18.0</td>
<td>19.1</td>
<td>6.1</td>
</tr>
</tbody>
</table>

Source: Seoul Development Institute 2005.

Note: Seven new lines of exclusive median-lane buses were opened in 2004.
Many urban centers suffer a heat-island effect, with temperatures higher than surrounding suburban and rural areas because of greater surface area coverage. Seoul is no exception. The spillover “cooling” benefits from the freeway-to-greenway conversion are revealed by a heat-island study that finds that ambient temperatures along the central-city stream were 3.3°C lower and temperatures along the greenway 5.9°C lower than along a parallel surface arterial five blocks away (Hwang 2006).

The longer-term consequences of Seoul’s bold experiment with urban land reclamation are yet to be seen. The hope and expectation of many urban planners and green politicians is that reclamation will slow the pace of new-town development, reduce the spatial mismatch between development north (primarily employment) and south (primarily housing) of the Han River, and spur redevelopment of former industrial land. More balanced infill development, planners hope, will make Seoul an attractive global city that appeals to international finance and businesses as well as tourists, professionals, and foreign investors.

**Singapore: Transit-Oriented Development Empowered by Transportation Demand Management**

The city-state of Singapore is internationally renowned for its successful integration of transit and regional development, placing the urbanized island of 5.1 million inhabitants on a sustainable pathway both economically and
environmentally. Its transformation over the post–World War II period from a backwater port awash in third-world poverty to a dynamic, modern, industrialized city-state has been remarkable.

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, looks like a constellation of satellite “planets,” or new towns, that surround the central core, interspersed by protective greenbelts and interlaced by high-capacity, high-performance rail transit. Radial rail links interconnect Singapore’s high-rise urban core with the hierarchy of subcenters, and a looping mix of heavy and light rail lines connects the subcenters (figure 2.9).

Like Stockholm and Copenhagen, this rail-served settlement pattern has produced tremendous transportation benefits. VKT per capita is among the lowest of any urbanized region in the world with per capita GDP of more than $25,000, and the annual number of transit trips per capita is high (484 in 2006) (UITP 2006).

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 on one another. Some satellite centers are primarily industrial estates, others are predominantly dormitory communities; most are mixed-use enclaves. About three-quarters of residents of master-planned new towns work outside their town. Most, however, commute within the radial corridor that connects their town to Singapore’s
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central business district. Travel is thus predominantly within, not between, rail-served corridors. The dispersal of mixed land uses along corridors has created two-way travel flows and spread travel demand more evenly throughout the day.

Singapore’s progressive “transit first” policies 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. Made up of high registration fees, import duties for automobile purchases, and a licensing surcharge based on a quota system (a certificate of entitlement that is indexed to congestion levels), these charges principally cover the fixed costs associated with providing basic levels of road infrastructure and parking facilities. The second tier of charges is use related, in the form of fuel taxes and parking fees. These charges cover the incremental costs for scaling road capacity to traffic volumes and maintaining roadway infrastructure. The third set of charges—in the form of real-time ERP—forces motorists to internalize the externalities they impose when using their cars during peak hours. Fees fluctuate according to congestion levels, forcing motorists to bear some of the costs they impose on others in the form of time delays and air pollution. Within a month of initiating ERP in 1998, traffic along a main thoroughfare fell 15 percent and average rush hour speeds rose from 36 to 58 kilometers per hour. Vehicle quotas, congestion prices, and an assortment of fees and surtaxes (which add as much as 150 percent to a car’s open market value) have reduced the annual growth of Singapore’s vehicle population from 6 percent in 1997 to less than 3 percent in 2010—a remarkable achievement for a city in which per capita incomes have risen faster over the past two decades than virtually anywhere in the world.

Charging motorists more to own and use cars is but one form of transportation demand management (TDM) found in Singapore. As in Europe, car sharing has gained a foothold in Singapore, the only Asian city where this is the case. Singapore also has an off-peak vehicle licensing scheme that allows vehicles holding such licenses to be used only during the morning and evening off-peak periods Mondays through Saturday and any time Sunday.

Although higher prices and TDM have boosted transit usage, their influences are being eclipsed by rising income, which continues to push up Singapore’s rates of car ownership and motorization. Singapore has among the most affordable housing (thanks to government provisions of mass-produced units), freeing up personal income for the second most costly durable good purchased by households, the private car. In the early 1990s, the ratio of the average housing price to average annual household income (2.3) was far lower than the ratio of the average price of a new car to income (3.7). Over the 1974–95 period, the price elasticity for car ownership was −0.45,
compared with an income elasticity of 1.00, according to one study (Chu, Koh, and Tse 2004). Even if automobile prices increase at twice the rate of household incomes, such elasticities suggest that motorization rates will continue to rise in Singapore.

Rising congestion is reflected by statistics on the density of cars on land-constrained Singapore’s fairly fixed supply of road supply. In 1995 (the year the vehicle quota system was introduced), the number of vehicles per kilometer of road was 180; by 2010, the figure had risen to 250. Car ownership increased by only 11 percent between 2000 and 2005; between 2005 and 2010, it increased 39 percent (Singapore Government n.d.).

In the face of this rapid rise in car ownership, Singapore is turning to higher congestion tolls as a way to temper motorization. The logic of raising congestion tolls is expressed in the long-term master plan: “Although congestion charges such as ERP encourage motorists to consider whether and when to drive, ownership costs are sunk costs and may in fact result in motorists driving more rather than less. Hence, as we expand the electronic road pricing (ERP) system, we will continue to shift the focus of our demand management strategies from ownership taxes to usage charges” (Singapore Land Transport Authority 2008, p. 57).

Singapore’s centralized form of governance has allowed land development and transit services, which are overseen by different authorities (the Urban Redevelopment Authority and the Land Transport Authority), to be closely coordinated, both institutionally and financially. Revenues generated from high vehicle ownership and usage charges, for instance, go to the general treasury, which channels them into vastly enhanced and expanded transit services as well as the construction of the armature of rail TODs (for example, sidewalk networks, civic squares, bus staging areas). Because of the island-state’s world-class transit service offerings and TOD built form, congestion tolls are politically possible, as for a significant share of trips, travel times are lower using public transit than private cars. Of 8.9 million daily motorized trips made in Singapore in 2010, 4.5 million were by rail or bus transit (Singapore MRT 2011). Long-range planning goals call for raising this share to two-thirds.

The role of rail transit in capturing larger shares of motorized trips has increased, and it is slated to continue to do so in coming years. The length of Singapore’s world-class rapid transit system more than doubled, to 138 kilometers in 2011 from 67 kilometers in 1990, leading to a doubling of ridership, to nearly 2 million riders a day, from a little under 1 million in 1998. In 1999, Singapore added automated light rail services to the mix, with trackage increasing from 8 kilometers in 1999 to 29 kilometers in 2010. Bus ridership in 2011 was only 1.5 times higher than total rail ridership, down from 3 times higher than rail in 1998. Singapore’s latest land transport master plan, released in 2008, embraces “making public transport a choice mode” and “managing road usage” as strategic thrusts toward retaining its status as a world-class transit metropolis.
Tokyo: Public-Private Urban Regeneration

Tokyo’s position as a global transit metropolis mimics that of Hong Kong SAR, China, and Stockholm, albeit in different ways. As in Hong Kong SAR, China, the private sector has historically linked transit investments and urban development through value capture mechanisms; as in Stockholm, the focus of the transit/land-use nexus has been on urban regeneration rather than new-town development in recent years, albeit more for market than urban policy reasons.

Tokyo’s railway network—owned and operated by a mix of public, private, and quasi-private entities—is by far the world’s largest. Most of the region’s extensive network of suburban railway lines was built by private companies that received government concessions and exclusive rights to design, build, and operate rail services. Tokyo’s railway companies have historically leveraged real estate development to both pay for infrastructure and produce profits for shareholders. They have opened convenience stores and shopping malls within and adjacent to stations.

What most distinguishes Tokyo’s railway companies is their construction of large-scale new towns on once virgin lands (Cervero 1998). West of central Tokyo, where many of the region’s most upper-market suburbs are located, entire communities are the domains of powerful conglomerates that are best known for their department store chains—Keio, Odakyu, Seibu, and Tokyu—but which first and foremost are in the business of railway and real estate development. All started as private railway companies that over time branched into businesses closely related to the railway industry, including real estate, retailing, bus operations, and electric power generation. Such business expansion made good economic sense; placing shopping malls, apartments, and entertainment complexes near stations generated rail traffic, and railways brought customers to these establishments. During the 1980s, at the height of railway/new-town co-development and a surge in Japanese real estate prices, railway companies were earning investment returns on ancillary real estate projects in the range of 50–70 percent, with profit margins from real estate far outstripping profits from transit services (figure 2.10).

Tokyu Corporation is Greater Tokyo’s largest private railway enterprise. It was among the first companies to advance the business model of railway/new-town co-development. From 1960 to 1984, Tokyu Corporation’s 23-kilometer rail line transformed a vast, hilly, scarcely inhabited area into a planned community, Tama Den-en Toshi (Tama Garden City), of a half million residents. Tokyu used land consolidation techniques to assemble farmland at cheap prices in advance of rail construction and to finance neighborhood infrastructure. Under this approach, landowners formed a cooperative that consolidated (often irregularly shaped) properties and returned them as smaller but fully serviced (usually rectangular) parcels. Roads, drainage, sewerage, parks, and other infrastructure were funded through the sale of the “extra” reserved land contributed by cooperative members. Land consolidation relieved railway companies such as
Tokyu from the up-front burden and risks of acquiring land and financing infrastructure.

A new era for Tokyo’s private railway companies began in the 1990s, when the bursting of Japan’s real estate price bubble saw the market valuations of rail companies’ landholdings fall. Powerful demographic trends, such as declining birth rates and an aging population, combined with the slowing of the economy, reduced the demand for new-town construction. To spread the risks of a shakier real estate market, private railway companies partnered with third parties to pursue large-scale development projects. Recent real estate projects of Tokyu Corporation, for example, have relied on Real Estate Investment Trust (REIT) funding.

Changing traffic conditions have also had a hand in changing the portfolios of Tokyo’s private railways. Greater Tokyo’s rail-served new towns and subcenters featured housing and retail services, but most white-collar jobs remained in the urban core (Cervero 1998; Sorensen 2001). The result was tidal radial patterns of commuting, which exacerbated traffic congestion in the urban core. Long commutes combined with crowded trains and roadways helped trigger a return-to-the-city movement. Several large-scale redevelopment projects are now underway as joint ventures between private railways and real estate companies, targeted at young professionals, empty-nesters, and other less traditional niche markets drawn to central-city living. In a break from tradition, when buildings above subway stations

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**Figure 2.10 Rates of return of private railway corporations in metropolitan Tokyo, 1980–96**

<table>
<thead>
<tr>
<th>Service</th>
<th>Return on Investment (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus service</td>
<td>-3.5</td>
</tr>
<tr>
<td>Rail service</td>
<td>5.4</td>
</tr>
<tr>
<td>Retail</td>
<td>15.9</td>
</tr>
<tr>
<td>Real estate</td>
<td>53.4</td>
</tr>
</tbody>
</table>


*Note:* Data cover 1980–96.
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were exclusively office or commercial projects, major subway stations now feature high-end housing and consumer services. Residential and commercial districts around several central-city stations, notably Akihabara, Shibuya, Shinagawa, and Shinjuku, are now abuzz with activity 24/7 (24 hours a day, 7 days a week) (figure 2.11).

Tokyo’s two former public railways, JR East and Tokyo Metro, are also pursuing the redevelopment and infilling of strategic central-city land parcels. In the case of JR East, mounting fiscal losses incurred by the former Japan National Railway (with an accumulated debt of $300 billion) led to privatization in 1987. At the time, the national government gave JR East large developable land parcels around terminal stations, prime for commercial redevelopment. Borrowing from the practices of the Tokyu Corporation and other private railway consortia, JR East and Tokyo Metro aggressively transformed these properties into high-rise commercial ventures. In 2006, real estate yielded returns on investment of more than 40 percent for both former public railways.

JR East’s showcase real estate project is Tokyo Station City, developed jointly with other private interests. Tokyo Station City features high-rise, class-A office buildings; retail centers; and hotels (figure 2.12). It is well suited for large-scale redevelopment, thanks to the large amount of buildable space above depots as well as high pedestrian traffic volumes. On a typical weekday in 2005, about half a million passengers passed through Tokyo station (JR East 2005).

Like MTRC in Hong Kong SAR, China, Tokyo’s private railways are clearly responding to market price signals, as indicated by an analysis of
2005 residential land prices along 16 mostly private railway corridors as a function of distance to central Tokyo. Within and along the Yamanote loop, where most large-scale redevelopment projects have been built on land owned by private railway companies, residential prices are generally twice what they are 15–20 kilometers from the center. Since 2000, the only area where residential land has gained value has been around terminal stations on the Yamanote loop.

It is at intermodal rail stops served by high-speed rail—notably, the Tokaido Shinkansen line—where urban development activities in Greater Tokyo have been most prominent. Around the newly opened Shinagawa Shinkansen station in central Tokyo, for example, the metropolitan government, the national government, the privatized Central Japan Railway Company, and private real estate developers joined forces to co-develop prestigious office towers and shopping malls. The project featured high-quality public green plazas and well-designed pedestrian circulation systems as a lure to firms and workers that place a premium on livability and are drawn to urban amenities when deciding where to open a business or to work.

These joint transit–commercial redevelopment efforts aim not only to increase the number of business passengers on the Tokaido Shinkansen line, but also to raise the potential of land value capture around the terminal

Figure 2.12  Tokyo Station City

Source: Japan Railway Corporation East (http://www.jreast.co.jp; reproduced with permission).
Note: This high-rise commercial project mixes the old and new, with the restored historical station (lower left) flanked by towering office, retail, and hotel structures.
stations. Nagoya, Shinagawa, and Tokyo and have considerably increased commercial land values within 5 kilometers of Shinkansen stations where large-scale redevelopment projects were delivered through public-private partnerships (figure 2.13). Compared with many private intercity railway corporations in Osaka and Tokyo, the former Japanese National Railways was historically reticent to capture land development benefits around the Nagoya Shinkansen stations. However, in response to Japan’s urban regeneration boom in the past decade, real estate revenue streams of the privatized Central Japan Railway Company (JR Central) soared—from ¥24.3 billion ($0.21 billion) in fiscal 1999 to ¥66.7 billion ($0.74 billion) in fiscal 2009—largely from the new commercial property packages redeveloped around the Nagoya Shinkansen station (JR Central 2011).

Washington, DC, and Arlington County, Virginia: A Transit-Development Success Story

More growth has occurred near metropolitan Washington, DC’s heavy rail system in the past quarter century than anywhere in the United States. From 1980 to 1990, 40 percent of the region’s office and retail space was built within walking distance of a Metrorail station (Cervero and others 2004).
The fact that the timing of the railway investment (late 1970s through 1980s) coincided with a rapid period of growth (more jobs were added in metropolitan Washington, DC than anywhere in the United States) helped steer new development to rail-served corridors. Combined with height limit restrictions within the District of Columbia and federal policy that mandates that government offices be located near rail stations, these factors encouraged TOD.

The recipient of most spillover growth from Washington, DC has been Arlington County, Virginia, just across the Potomac River (Cervero and others 2004). This 26-square-mile county just south of the nation’s capital has experienced a tremendous increase in building activity since the opening of Washington Metrorail in 1978. More than 25 million square feet of office space, 4 million square feet of retail space, 25,000 mixed-income dwelling units, and 6,500 hotel rooms were built over the past three decades.

Much of this growth has been wrapped around Metrorail stations, guided by a “necklace-of-pearls” vision articulated in the “bull’s eye” concept plan adopted in the late 1960s (figure 2.14). Of the nearly 190,000 people living in Arlington County, 26 percent reside within a Metrorail-served corridor (roughly a quarter mile walk shed from the station), even though these corridors represent only 8 percent of county land area. If the development added to these two corridors had been built at suburban density standards, as in neighboring Fairfax County, Virginia, seven times as much land area would have been required.

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. Before Metrorail, planners in Arlington County understood that high-performance transit provided an unprecedented opportunity to shape growth. They introduced various strategies—targeted infrastructure improvements, incentive zoning, development proffers, and permissive and as-of-right zoning—to entice private investment around stations. After preparing countywide and station-area plans on desired land-use outcomes, density and set-back configurations, and circulation systems, they changed zoning classifications, allowing developments that complied with these classifications to proceed unencumbered. The ability of complying developers to create TODs “as-of-right” (which ensures the issuance of development permits as long as projects adhere to the requirements of local plans) was particularly important. It allowed developers to line up capital, secure loans, incur up-front costs, and phase in construction without fear that the local government might change its mind regarding permitted uses, building densities, and the like.

Another key factor that gave rise to TODs was the decision not to set Arlington County’s Metrorail rail corridor in the median of Interstate 66. Instead, county officials persuaded the region’s transit authority to align the corridor in traditional urban centers to help jump-start the process of
urban regeneration, even though doing so substantially increased construction costs.

Arlington County’s transit ridership statistics reveal the payoff of concentrated growth along rail corridors. The county boasts one of the highest percentages of transit use in the Washington region, with 39.3 percent of Metrorail corridor residents commuting to work by public transit—twice the share among county residents who live outside the Metrorail corridors. At several apartments and condominium buildings near the Rosslyn and Ballston stations, about two-thirds of employed residents take public transit to work.
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. Counts of station entries and exits in Arlington County are nearly equal during both peak and off-peak hours. As a result, trains and buses are largely full in both directions. The presence of so much retail, entertainment, and hotel activity along the county’s Metrorail corridors has filled trains and buses during midday and on weekends. Arlington County averages more passengers at its stations in off-peak hours than other jurisdictions in the region except downtown Washington, DC. Balanced mixed-use development has translated into as close to a 24/7 ridership profile as any U.S. setting outside a central business district.

Part of the credit for the transit-oriented growth of Arlington County is the entrepreneurial leanings of the region’s rail authority. Over the past two decades, the Washington Metropolitan Area Transit Authority (WMATA)—an independent regional transportation authority responsible for designing, building, and operating the region’s rail transit and public bus services—has aggressively sought to recapture value through joint development activities. Metrorail’s joint development program of air-rights leases and station connection fees generate about 2 percent of the system’s annual revenues; increased ridership—and thus fare-box intake—at least doubles this percentage (Cervero and others 2004).

Proactivism accounts for much of WMATA’s joint development success. A vital step in WMATA pursuing value capture was the creation of a real estate development department within the agency at the very beginning, before the construction and opening of railway services. By hiring seasoned real estate professionals to staff and manage this department, WMATA positioned itself to seek out remunerative joint development possibilities. Private-sector experiences helped create a more entrepreneurial approach to land development than is found at most U.S. transit agencies. Staff members were given the financial resources to purchase land around planned rail stations on the open market, often before formal plans were announced and thus at fairly reasonable prices. Rather than waiting and reacting to developer proposals, WMATA’s real estate office actively sought out mutually advantageous joint development opportunities. With financial and institutional support from board members, WMATA’s real estate office has over time amassed an impressive portfolio of landholdings, much of it purchased on the open market. To date, WMATA had undertaken more than 30 development projects at a value of more than $2 billion on land the agency owns.

Over time, WMATA has refined its joint development activities. Station sites are carefully screened according to a set of criteria that gauge development potential. For sites selected, a request for proposals is issued to solicit developer interests. Through negotiations, a developer team is chosen and contracts specifying the financial terms of the deal are drawn up. With the help of a private real estate firm, WMATA now rates potential
sites according to the likely degree of private sector interests and development constraints.

Because joint development is controlled by a transit agency, it is the form of value capture that has the greatest potential for financing rail investments in much of the world. It requires, however, an institutional capacity to expand beyond the traditional mission of transit agencies (that is, building and operating transit services) to venture into other entrepreneurial realms, such as real estate development and co-development. As suggested by experiences in metropolitan Washington, institutional reforms are often a necessary part of any successful transit value capture scheme.

**Integrating Transit and Land-Use Planning through Adaptive Transit and Bus Rapid Transit**

The two cases reviewed in this section—Curitiba and Ottawa—are given the “adaptive transit” moniker mainly because they turned to an inherently flexible technology—the rubber-tire bus—as high-capacity transit carriers. Both cities feature high-rise, mixed-use development around a number of BRT stations but also retain many lower-density neighborhoods that are served by feeder lines. Thus, they rely on adaptive bus-based transit to provide a versatile mix of transit services while also supporting rail-like TOD.

**Curitiba, Brazil: The Lineal Bus Rapid Transit Metropolis**

Curitiba is internationally renowned as one of the world’s most sustainable, well-planned cities, in large part because of its success at integrating BRT investments and urban development. The city’s experiences underscore the environmental benefits of balancing urban growth along bus-served linear axes and aggressively pursuing a “transit first” policy. 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, streams of double-articulated (that is, two accordion section) buses haul 16,000 passengers an hour, comparable to the number much pricier metrorail systems carry. The city’s system of 390 routes served by 2,000 vehicles carries 2.1 million passengers a day, twice as many as in 1990. To ensure a transit-oriented built form, Curitiba’s government mandates that all medium- and large-scale urban development be sited along a BRT corridor. Orchestrating regional growth is the Institute for Research and Urban Planning (IPPUC), an independent entity charged with ensuring integration of all elements of urban growth.

A design element used to enhance accessibility in Curitiba is the “triinary”—three parallel roadways with compatible land uses and building heights that taper with distance from the BRT corridor (figure 2.15). Zoning ordinance and urban design standards promote ridership productivity and environmental quality. The first two floors of the busway that do not count against permissible plot ratios (building height/land area) are devoted
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To retail uses. Above the second floor, buildings must be set back at least five meters from the property line, to allow sun to cast on the transitway. The inclusion of upper-level housing entitles property owners to density bonuses, which has led to vertical mixing of uses within buildings. An important benefit of mixed land uses and transit service levels along these corridors, in addition to extraordinarily high ridership rates, has been balanced bidirectional flows, ensuring efficient use of bus capacity, just as in Stockholm and Arlington County, Virginia. The influences of the trinary structure on channeling trips are revealed by 2009 origin-destination statistics, which indicate that 78 percent of passengers boarding at the terminus of the north-south corridor are destined to a bus stop on the same corridor (Duarte and Ultramari 2012).

Curitiba is one of Brazil’s wealthiest cities, yet it averages considerably more transit trips per capita than Rio de Janeiro and São Paulo, which are much larger. Its share of motorized trips by transit (45 percent) is the highest in Latin America (Santos 2011). High transit use has appreciably shrunk the city’s environmental footprint. Curitiba’s annual congestion cost per capita of $0.67 is a fraction of São Paulo’s ($7.34) (Suzuki and
The city also boasts the cleanest air of any Brazilian city with more than 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.

Sustained political commitment has been an important part of Curitiba’s success. The harmonization of transit and land use took place over 40 years of political continuity, marked by a progression of forward-looking, like-minded mayors who built on the work of their predecessors. A cogent long-term vision and the presence of a politically insulated regional planning organization, the IPPUC, to implement the vision have been crucial in allowing the city to chart a sustainable urban pathway.

In recent years, Curitiba has begun to experience the limits of rubber-tire technologies. With buses operating on 30-second intervals on main routes during peak hours, bunching problems have disrupted and slowed services. Veritable “elephant trains” of buses have increased operating costs and precluded the kinds of economies of scale enjoyed by trains operated by a single driver. Extreme overcrowding has prompted many middle-class car-owning travelers to switch to driving. In the words of one urban planner, “Many Curitibanos view [BRT] as noisy, crowded and unsafe. Undermining the thinking behind the master plan, even those who live alongside the high-density rapid-bus corridors are buying cars” (Lubow 2007, p. M8). A long-discussed light rail line, to replace overcrowded buses, has yet to gain momentum, mainly because of cost concerns.

The Green Line is the city’s first new BRT corridor in years, an 18-kilometer corridor that was converted from a federal highway. Like Bogota’s celebrated BRT, the Green Line has passing lanes, which greatly increase capacity by supporting express services.

Meanwhile, recent legislation has taken bold steps to alter zoning and land use along the Green Line to promote TOD. Formerly a national highway dotted with truck stops and lumberyards, this hodgepodge of industrial uses is slated to become a pedestrian-friendly, mixed-use corridor that can accommodate up to half a million new residents.

As important to the enrichment of services in Curitiba is an evolved view of BRT corridors as rights of way that also accommodate linear parks (strips of long park areas located to next to railways, bus lines, roads, canals, or rivers) and bike paths. A law passed in 2010 promotes the preservation of green space along the corridor by giving developers increased building rights if they purchase or preserve land along the corridor as parks.

Ottawa: North America’s First High-End Bus Rapid Transit

North America’s best example of BRT–based TOD comes from Canada’s capital, Ottawa. Borrowing a chapter from Scandinavian metropolises like Copenhagen and Stockholm, Ottawa’s leaders began with a concept plan that defined desired growth axes and then strategically invested in a high-quality, high-capacity transitway to drive growth along these corridors.
As a result of supportive zoning and world-class bus services, growth gravitated to bus corridors between 1985 and 2000.

Institutional factors partly account for Ottawa’s success in implementing a long-range vision. A regional planning body, the Regional Council, was formed in 1969 to carry out comprehensive planning, invest in major infrastructure, and provide regional services such as air quality management. A checks-and-balances system is in place in which localities oversee land-use decisions, which the regional authority can override if it considers them incompatible with the regional plan. In practice, the regional authority rarely overrules the wishes of municipalities.

Based on broad-based citizen input, in 1974, the Regional Council endorsed a multicentered urban structure: downtown Ottawa would retain its position as the dominant commercial, employment, and cultural center.
of the region, and it would be surrounded by a hierarchy of primary and secondary urban centers, interconnected by high-quality transit. Market-driven (predominantly low-density) patterns of development would be permitted outside these centers.

The chief instrument for achieving this desired physical form was the busway. With a vision in place and the agreement to build a busway to make the vision a reality, the Regional Council turned its attention to land-use management. TOD policies were introduced that called for substantial increases in the share of regional jobs located near Transitway stations. The long-term goal called for 40 percent of the region’s jobs to be within walking distance (400 meters) of the Transitway. The two principal suburban catchments for job growth, the Orléans and Kanata urban centers, were slated to host more than 10,000 new jobs. The official plan also required that regional shopping centers with more than 375,000 square feet (34,840 square meters) of gross leasable space be sited near the Transitway or future extensions.

Ottawa officials also adopted a “transit first” policy early in their BRT planning: improvements to the existing transit system and the development of rapid transit were to take precedence over all forms of road construction and widening. The regional plan specifically called for creating rapid transit services. No commitments were made on preferred routing or transit technologies.

Ottawa opted for a busway at a time when every other medium-size North American metropolis investing in new transit systems selected the eminently more popular light rail transit technology. Similar in size to Ottawa, Calgary and Edmonton both constructed regional light rail systems in the 1970s and 1980s; Vancouver, Canada’s third-largest metropolis, built an elevated “advanced” light rail system, called SkyTrain. The decision to go with a busway made the Ottawa-Carleton region a maverick of sorts, but in dollars and cents it made good sense, as busways were shown to be 30 percent less expensive to build and 20 percent less expensive to operate than a light rail. Because of the busway’s relatively high operating speeds, the region has been able to get by with 150 fewer buses than it would have needed to carry the same number of passengers on surface streets. These savings exceeded the $275 million capital outlay for the first 20 kilometers of the busway.

Perhaps most important, a busway was better suited to the region’s future land-use vision of concentrated workplaces and retail destinations encircled by largely low-density, single-family detached housing. From a travel standpoint, such a settlement pattern translates into “many-to-few” trip origins and destinations. A point-to-point rail system, planners reasoned, was incompatible with this spatial pattern of trips. Rather, they reasoned, the geometry of a flexible busway system that allowed trunkline buses to morph into neighborhood feeders was much more compatible with the geography of future travel. As in all good transit metropolises, a close
correspondence between the physical design of transit and spatial pattern of trip making was achieved.

Within the first year of operation, Ottawa’s busway outperformed all other North American busway and light rail systems built in the early 1990s by nearly four to one on a passenger per guideway-mile basis (figure 2.17). With more than 140 public transit trips per person per year, Ottawa has one of the highest transit utilization rates in North America, even when compared with much larger rail-served cities like Chicago and Philadelphia.

As with successful transit metropolises in Scandinavia and elsewhere, Ottawa’s TOD vision was buttressed by a series of TDM measures that aimed to level the playing field by either regulating car use or passing on price signals to motorists that began to reflect broader societal costs. Most notable were parking policies. When the Transitway opened in 1983, the federal government began eliminating free parking for its employees and reducing the number of downtown parking spaces. By 1984, downtown Ottawa had 15 percent fewer parking spaces than in 1975, despite a near doubling of office space. The federal government also introduced flexible working schedules for its employees, producing a more even distribution of transit usage over the course of the day. Supportive parking policies were also introduced at busway stations. OC Transpo (the Ottawa-Carleton

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**Figure 2.17 Passengers per guideway mile in selected North American busway and light rail systems**

<table>
<thead>
<tr>
<th>Busway</th>
<th>Ottawa</th>
<th>Pittsburgh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light rail</td>
<td>Edmonton</td>
<td>3,906</td>
</tr>
<tr>
<td></td>
<td>Boston</td>
<td>3,754</td>
</tr>
<tr>
<td></td>
<td>Calgary</td>
<td>2,143</td>
</tr>
<tr>
<td></td>
<td>Portland</td>
<td>1,299</td>
</tr>
<tr>
<td></td>
<td>San Diego</td>
<td>1,275</td>
</tr>
<tr>
<td></td>
<td>Pittsburgh</td>
<td>1,244</td>
</tr>
<tr>
<td></td>
<td>Sacramento</td>
<td>874</td>
</tr>
<tr>
<td></td>
<td>San Jose</td>
<td>534</td>
</tr>
<tr>
<td></td>
<td>Buffalo</td>
<td>469</td>
</tr>
</tbody>
</table>

*Source: Cervero 1998; adapted with permission from Island Press, Washington, DC.*

*Note: Data are for 1991–93.*
Regional Transit Commission) restricted park-and-ride facilities to the busway’s terminuses to encourage the use of feeder and express services as well as to increase the development potential of selected stations. Other requirements included zoning targets of placing 40 percent of future job growth and all regional trip generators of more than 100,000 square meters within 400 meters of a busway stop.

In addition to “sticks,” various pro-transit “carrots” were concurrently introduced, including one of the first bus-based, real-time passenger information systems anywhere; targets for transit mode splits for cordon lines throughout the region (which govern where service improvements are directed); and eco-passes, which provide regular transit users with deep fare discounts. In 1982–85, the city adopted a set of TOD design guidelines that call for, among other things, building setbacks to create human-scale development; public art to enliven station areas; and short street blocks, cut-through walkways, and easy way-finding to enhance the quality of pedestrian environments linked to busway stations (Municipality of Ottawa 2007).

Like Curitiba, Ottawa has experienced some of the growing pains, and limitations, of a highly successful BRT system. Historically, more than 60 percent of regional buses on the Transitway passed through a downtown one-way, surface-level couplet (two one-way streets that run parallel to
each other) causing peak-period traffic snarls and the bunching of buses. With passenger throughput having reached the capacity of a surface transit system, a decision was made to convert the downtown busway into a light-rail subway alignment.

The Downtown Tunnel, expected to cost about $1.4 billion, is the single costliest transit investment under consideration in Ottawa. It would extend the O-Train light rail, which began operation in 2001 as a pilot project to evaluate the benefits of converting Ottawa’s Transitways to light rails, north through downtown (figure 2.18). Local officials are quick to point out that BRT is not being abandoned but simply converted to light rail transit along the highest-capacity downtown Transitway corridor. Indeed, new or expanded BRT Transitways are planned in the east, west, and south portions of metropolitan Ottawa.

Ottawa’s past three decades of “transit first” policies continue to pay off in terms of high ridership levels. Transit use has increased steadily since 1998, by about 3.5 percent a year. From 70 million passengers in 1998, annual ridership reached about 100 million in 2010. Ottawa’s transit mode share has remained steady, at nearly 15 percent of daily trips, despite declining mode shares in almost all other Canadian cities (Municipality of Ottawa 2008).

Conclusion

A number of lessons can be drawn from international best-case experiences that have direct relevance to cities in developing countries and elsewhere that are investing in BRT and other high-capacity transit systems. Chapter 4 highlights these lessons.

One overarching principle followed by all cities is that successful transit and land-use integration requires a cogent vision of the future city. Visions of how the city will ideally grow and the role of transportation investments and policy in achieving this urban-form vision were well articulated in all cases. Moreover, land-use visions shaped transportation decisions far more than vice versa, reflecting the core notion that transportation is a means, not an end unto itself. For adaptive cities, the vision of compact, mixed-use, often lineal corridors produced “necklace-of-pearls”—style built forms and induced sustainable mobility choices. For adaptive transit, policy focused on investing in flexible, lower-cost transit systems, like BRT, which can better serve market-driven patterns of development. It is this unwavering commitment to linking transit investments and urban development in mutually beneficial and reinforcing ways that distinguishes these successful global cases.

Applying such principles and practices to rapidly growing and motorizing cities in developing countries is a challenge. Chapter 3 describes how four cities—Ahmedabad, India; Bogota, Colombia; Guangzhou, China; and Ho Chi Minh City, Vietnam—are meeting this challenge.
### Annex Table 2A.1  Modes of transportation in selected cities

<table>
<thead>
<tr>
<th>City (Region)</th>
<th>Population</th>
<th>Population density (residents per square kilometer)</th>
<th>Area (square kilometers)</th>
<th>Car ownership (cars owned per 1,000 residents)</th>
<th>Transit ridership (annual riders per capita)</th>
<th>Mode of transportation in city (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>City</td>
<td>Metropol-</td>
<td>GDP per capita (US dollars)</td>
<td>Metropol-</td>
<td>City</td>
<td>Public transit</td>
<td>Private automobile</td>
</tr>
<tr>
<td></td>
<td>lan area</td>
<td></td>
<td>lan area</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Copenhagen,</td>
<td>662,600</td>
<td>5,407</td>
<td>123</td>
<td>184</td>
<td>228</td>
<td>27 40   33  —</td>
</tr>
<tr>
<td>Curitiba, Brazil</td>
<td>1,764,500</td>
<td>4,062</td>
<td>430</td>
<td>15,417</td>
<td>400</td>
<td>355  —  —  —</td>
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<td>Hong Kong SAR,</td>
<td>7,061,200</td>
<td>6,480</td>
<td>1,104</td>
<td>82</td>
<td>574</td>
<td>88 11   1  —</td>
</tr>
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<td>Ottawa, Canada</td>
<td>883,400</td>
<td>317</td>
<td>2,778</td>
<td>557</td>
<td>142</td>
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<td>Singapore</td>
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<td>694</td>
<td>100</td>
<td>263</td>
<td>63 27   0 10</td>
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<tr>
<td>Seoul, Republic</td>
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<td>17,000</td>
<td>605</td>
<td>1,897</td>
<td>1,028</td>
<td>69 26   5 —</td>
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<td>382</td>
<td>6,519</td>
<td>373</td>
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<td>6,027</td>
<td>2,188</td>
<td>13,752</td>
<td>1,107</td>
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</tr>
<tr>
<td>Washington, DC</td>
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<td>3,886</td>
<td>177</td>
<td>14,412</td>
<td>680</td>
<td>63 37   48 3 12</td>
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<td>Note: Figures in parentheses show the year of the data. — = Not available.</td>
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Note

1. Conversion calculated based on exchange rate of $1= ¥ 114.37 in 1999 and ¥ 93.52 in 2009.

References


Foundation City Bikes. 2009. “Copenhagen City Bike.”


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