Transforming the Urban Space through Transit-Oriented Development

The 3V Approach

Serge Salat and Gerald Ollivier

WORLD BANK GROUP
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MDTF Sustainable Urbanization

Serge Salat and Gerald Ollivier
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About the Authors

Serge Salat, President, Urban Morphology and Complex Systems Institute, Paris
Serge Salat is an architect, urban planner and designer, and urban economist who advises cities and international institutions—including the Asian Development Bank, the Caisse des Dépots et Consignations, the Intergovernmental Panel on Climate Change, UN-Habitat, the United Nations Environment Programme and the World Bank, on urban planning, TOD, urban policy, and urban economic growth. The author of 60 research papers and 5 books, he is one of the world’s leading experts on urban morphology and a member of the United Nations International Resources Panel. He holds a PhD in economics from the Université Paris Dauphine, a PhD in architecture from the Ecole d’Architecture de Paris-la-Villette, and a PhD in the history of civilizations from the Ecole des Hautes Études en Sciences Sociales (EHESS).

Gerald Ollivier, Lead Transport Specialist, World Bank
Gerald Ollivier is a civil engineer and a financial analyst. He is the Transport Cluster Leader for the World Bank’s Singapore Hub and the leader of the Bank’s Community of Practice on TOD. Before moving to Singapore, he spent five years in China, where he led the Transport Transformation and Innovation Knowledge Platform (TransForm) and supported the development of mass transit and high-speed rail lines with a focus on TOD-based integrated transport and land use planning. He holds an MSc in civil engineering (project management) from l'École Nationale des Travaux Publics de l'État and a Chartered Financial Analyst charter from the CFA Institute.
# Book at a Glance

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<td>Embrace nonuniform densities, concentrating jobs where accessibility is</td>
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\(^a\) 3V stands for 3 Value.
Message to City Leaders

Imagine a city that is more competitive, with higher-quality neighborhoods, lower infrastructure costs, and lower CO₂ emissions per unit of activity. This city has lower combined transportation and housing costs for its residents than other cities at similar levels of economic activity. Its residents can access most jobs and services easily through a combination of low-cost public transport, walking, and cycling. Its core economic and population centers are resilient to natural hazards. It is able to finance improvements to public space, connectivity, and social housing by capturing value created through integrated land use and transport planning. Such a vision has never been more relevant for rapidly growing cities than it is today.

Transit-oriented development (TOD) can play a major role in achieving such a vision. It is a planning and design strategy to achieve compact, mixed-use, pedestrian and bicycle-friendly urban development closely integrated with transit stations. It embraces the idea that locating amenities, employment, shops, and housing around transit hubs promotes the use of public transit and nonmotorized travel. Well-planned TOD at the city level is inclusive, because it focuses on ensuring access to jobs for all social groups through public transit.

TOD is often considered an effective way to create value through good design combined with good planning at the neighborhood level. Good urban design supports increased density and ensures that people do not feel oppressed by congestion and density. It requires significant streetscape improvement to turn streets into places for people. It creates a spirit of place; makes a city more “legible”; and evokes a feeling of enclosure, human scale, coherence, image, and linkage.

For rapidly growing developing cities, TOD needs to go beyond the mere redevelopment of specific neighborhoods. It must create an urban space able to accommodate hundreds of thousands or even millions of new residents in a way that provides high accessibility to jobs at the city level combined with amenities, services, and good-quality environment at the neighborhood level to give a sense of community. In such a context, TOD becomes relevant at the metropolitan and city scale.

Observation of large sustainable cities reveals wide variation in densities, which needs to be reflected in TOD planning. Jobs concentrate where accessibility to other firms is greatest. Housing concentrates in areas with good job accessibility by public transport. Large cities follow a finely orchestrated hierarchy of centers and subcenters, with high peaks of concentration of jobs and housing in areas with high transit accessibility. Recognizing this natural concentration can help design more effective urban space and mass transit networks.
Mass transit systems shape the city form and the distribution of its economic densities for decades. Stations that are more central, are more connected to others, and have more traffic play a special role in such process, which needs to be reflected in TOD planning. Feedback loops between transit network characteristics and density patterns tend to be self-reinforcing and appear to create a lock-in effect. Cities can thus be described as networks from which locations emerge. Accordingly, determining the shape of the mass transit network becomes central to creating a compact urban form combining core and polycentric centers well linked by transit.

Applying the concept of integrated economic, transport, and land use planning is often complex, because different agencies do not understand it in the same way. The use of clear objectives for accessibility at the city level can facilitate such integration. Singapore, for example, decided that by 2030, 80 percent of residents will live within 10-minute walk from a train station and 75 percent of peak-hour trips will be made by public transport. Such objectives can be achieved only through an integrated interagency approach, applying TOD principles for job and housing concentration around stations.

Based on an observation of methodologies applied in different countries, the Bank's Community of Practice on Transit Oriented Development has developed a methodology called the 3 Value (3V) Framework, which considers the node, place, and market potential value of each station. The 3V Framework outlines a typology to facilitate TOD implementation at the metropolitan and urban scale in various contexts as part of a methodology that aims to:

- identify the economic development potential of different transit corridors and different areas around mass transit stations in terms of type, scale, and timing, considering the level of connectivity and market demand through quantified indicators
- develop planning and implementation measures and prioritize limited public resources to create such value through coordinated interagency measures
- develop and communicate with residents, government agencies, and private developers a vision for the city that articulates development around its mass transit network.

By doing so, the 3V Framework can facilitate an alignment of TOD strategies at the metropolitan, city, network, and local levels.

The 3V Framework equips policy and decision makers with quantified indicators to better understand the interplay between the economic vision for the city, its land use and mass transit network, and urban qualities and market vibrancy around its mass transit stations. It enables agencies in charge of transport, land use, and economic planning to identify misalignments and to select measures to address those. On the basis of such a vision, planners can provide the necessary service infrastructure to support higher densities in priority areas and analyze the specific economic returns of different programs, considering all related social and environmental aspects, responding in particular to the challenges of an equitable urban growth.

This book provides examples of approaches taken by cities like London and New York to align their economic, land use, and transport planning to generate
jobs and high value. It illustrates the application of the 3V Framework in reviewing plans for the city of Zhengzhou, in China. We hope the book will help readers develop a coherent vision, policies, and strategy to leverage the value created through enhanced connectivity and accessibility and make cities even more appealing places to live, work, play, and do business.

Ede Jorge Ijjasz-Vasquez  
Senior Director  
Social, Urban, Rural and Resilience Global Practice  
The World Bank Group

Jose Luis Irigoyen  
Senior Director  
Transport and ICT Global Practice  
The World Bank Group
### Abbreviations

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<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>BCR</td>
<td>Building to Cost Ratio</td>
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<tr>
<td>BedZED</td>
<td>Beddington Zero Energy Development</td>
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<td>BRT</td>
<td>Bus Rapid Transit</td>
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<td>CASA</td>
<td>Centre for Advanced Spatial Analysis</td>
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<td>CBD</td>
<td>Central Business District</td>
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<td>CTOD</td>
<td>Center for Transit Oriented Development</td>
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<td>DBLVC</td>
<td>Development-Based Land Value Capture</td>
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<tr>
<td>DfT</td>
<td>Department for Transport (UK)</td>
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<td>DIB</td>
<td>District Improvement Bonuses</td>
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<td>DIF</td>
<td>District Improvement Fund</td>
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<td>DLR</td>
<td>Docklands Light Railway</td>
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<td>EHESS</td>
<td>Ecole des Hautes Etudes en Sciences Sociales</td>
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<td>ESMAP</td>
<td>Energy Sector Management Assistance Program</td>
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<tr>
<td>FAR</td>
<td>Floor Area Ratio</td>
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<td>FSI</td>
<td>Floor Space Index</td>
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<td>FSR</td>
<td>Floor Space Ratio</td>
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<td>GDP</td>
<td>Gross Domestic Products</td>
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<td>GVA</td>
<td>Gross Value Added</td>
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<td>H+T®</td>
<td>Housing + Transportation</td>
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<tr>
<td>HKSAR</td>
<td>Hong Kong Special Administrative Region</td>
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<tr>
<td>HS1</td>
<td>High Speed 1 (Channel Tunnel Rail Link)</td>
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<tr>
<td>HS2</td>
<td>High Speed 2 (Channel Tunnel Rail Link)</td>
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<tr>
<td>HSR</td>
<td>High Speed Rail</td>
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<tr>
<td>HYDC</td>
<td>Hudson Yards Development Corporation</td>
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<tr>
<td>HYIC</td>
<td>Hudson Yards Investment Corporation</td>
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<tr>
<td>ICT</td>
<td>Information and Communications Technology</td>
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<tr>
<td>IRT</td>
<td>Interborough Rapid Transit Company</td>
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<td>ITDP</td>
<td>The Institute for Transportation and Development Policy</td>
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<tr>
<td>KCCLP</td>
<td>King's Cross Central Limited Partnership</td>
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<tr>
<td>LCR</td>
<td>London and Continental Railways</td>
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<td>LEED</td>
<td>Leadership in Energy and Environmental Design</td>
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<tr>
<td>LIRR</td>
<td>Long Island Rail Road</td>
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<tr>
<td>LSE</td>
<td>London School of Economics</td>
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<tr>
<td>LTA</td>
<td>Land Transport Authority</td>
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<tr>
<td>LVC</td>
<td>Land Value Capture</td>
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<tr>
<td>MRT</td>
<td>Mass Rapid Transit (Hong Kong SAR, China)</td>
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<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>MTA</td>
<td>Metropolitan Transport Authority (NYC)</td>
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<td>MTRC</td>
<td>Mass Transit Railway Corporation</td>
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<td>NYCED</td>
<td>New York City Economic Development Corporation</td>
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<td>NYCIDA</td>
<td>New York City Industrial Development Agency</td>
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<td>OECD</td>
<td>Organization for Economic Co-operation and Development</td>
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<tr>
<td>OSD</td>
<td>Over Station Development</td>
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<tr>
<td>PILOT</td>
<td>Payments In Lieu Of Taxes</td>
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<td>PPP</td>
<td>Public-Private Partnership</td>
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<td>R+P</td>
<td>Rail Plus Property (program implemented by MTR Corporation, Limited, Hong Kong SAR, China)</td>
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<tr>
<td>RTS</td>
<td>Rapid Transit System</td>
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<td>SAR</td>
<td>Special Administrative Region</td>
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<td>TAD</td>
<td>Transit-Adjacent Development</td>
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<td>TDR</td>
<td>Transferable Development Rights</td>
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<td>TFL</td>
<td>Transport for London</td>
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<td>TIF</td>
<td>Tax Increment Financing</td>
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<td>TOD</td>
<td>Transit-Oriented Development</td>
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<td>TransFORM</td>
<td>Transport Transformation and Innovation Knowledge Platform (China-World Bank)</td>
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<td>ULI</td>
<td>Urban Land Institute</td>
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<td>URA</td>
<td>Singapore Urban Redevelopment Authority</td>
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<td>UTEP</td>
<td>Uniform Tax Exemption Policy</td>
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<td>VOA</td>
<td>Valuation Office Agency</td>
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<td>VoT</td>
<td>Value of Time</td>
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<td>ZHVI</td>
<td>Zillow Home Value Index</td>
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Agglomeration effects: Benefits from concentrating output and housing in particular areas.

Air rights sale: Sale of unused development rights on a given property to another developer allowing it to go beyond the limits specified in land use regulations (for example, FAR). Such sale, often by the government, allows funds to be raised to finance public infrastructure and services.

Betweenness centrality: Number of times a node in a network acts as a bridge along the shortest path between two other nodes. The concept, introduced by Linton Freeman in 1977, quantifies the control of one person over communication between other people in a social network. Nodes that have a high probability of occurring on a randomly chosen shortest path between two randomly chosen nodes have high betweenness. In transit networks, a station with high betweenness centrality has greater influence over the transfer of passengers through the network. These stations areas have high development potential.

Building coverage ratio: Size of constructed buildings’ floor in relation to total size of land plot. Building area is the floor space of a building when looking down at it from above (aerial view). The formula for building coverage ratio (BCR) is as follows: BCR (percent) = (building area)/ (site area) × 100.

Catalytic development: Holistic development to revitalize the urban fabric through a series of projects that drive and guide urban development.

Central business district (CBD): Areas where cities’ major businesses (financial institutions, stores, convention and sport facilities, hotels, and so forth) are concentrated. CBDs produce agglomeration economies.

Centrality: In graph theory and network analysis, indicators of centrality identify the most important nodes. Centrality can be used to identify the most influential people in a social network, key infrastructure nodes in the Internet or urban networks, and superspreaders of disease. Betweenness, closeness, and degree centrality are the three most important indicators for transit networks.

Closeness centrality: A measure of accessibility to a node within a network that measures the inverse of the sum of the distances of a node from all other nodes.
Compact city: Urban planning and urban design concept that promotes city with short travel distances. Compact cities are usually based on concentrated residential density, mixed land use, an efficient public transit system and an urban layout that encourages walking and cycling, low energy consumption, and reduced pollution. A compact city provides opportunities for social interaction as well as a feeling of safety. It is more sustainable than urban sprawl, because it is less dependent on the car and requires less (and cheaper per capita) infrastructure provision.

Degree centrality: Number of ties a node has with other nodes in a network. In transit networks, interchange stations between many lines or modes (hubs) have a high degree centrality.

Density gradient: Spatial variation in density over an area.

Employment density: Number of jobs in an area.

Enclosure: Degree to which buildings, walls, trees, and other vertical elements define streets and other public spaces.

Floor area ratio (FAR): Ratio of a building’s total floor area to the size of the land on which it is built. The higher the FAR, the higher the density. Also referred to as floor space ratio (FSR) or floor space index (FSI).

Floor space index (FSI): See Floor area ratio (FAR).

Greenfield development: New development that takes place on lands that were not previously developed as urban land, including agricultural, rural, and unused land.

Human density: Total number of people and jobs in an urban area divided by the land area.

Infill: Rededication of land in an urban environment, usually open space, to new construction or construction on any undeveloped land.

Intensification area: Built-up area with good existing or potential public transit links that can support redevelopment at higher than existing densities.

Intensity of node activity: Strength of traffic flows in a node; can be described by frequency of departures by public transportation and/or ridership.

Intermodal hub: Place where passengers can switch between different lines or transport modes. Intermodal hubs include large subway stations with multiple lines, train stations, rapid transit stations, bus stations, tram stations, and airports. Some complex hubs combine several modes in a single integrated multimodal station or complex of stations.
**Land readjustment scheme**: Scheme in which landowners pool their land for reconfiguration and contribute a portion of it for sale to raise funds to partially defray the costs of developing public infrastructure.

**Land value capture (LVC)**: Public financing method in which governments (a) trigger an increase in land values through regulatory decisions (for example, the change in land use or floor area ratio) and/or infrastructure investments; (b) institute a process to share the land value increment by capturing part or all of the change; and (c) use the proceeds to finance infrastructure investments (such as investments in transit and TOD or other improvements required to offset impacts related to the changes (for example, densification) and/or implement public policies to promote equity (for example, provision of affordable housing to alleviate shortages and offset potential gentrification). There are two main categories of LVC: development-based LVC and tax- or fee-based LVC. Development-based LVC can be facilitated through direct transaction of properties whose values have been increased by public regulatory decisions or infrastructure investment. Tax- or fee-based LVC is facilitated through indirect methods, such as extracting surplus from property owners through various tax or fee instruments (such as property taxes, betterment charges, and special assessments).

**Legibility**: Ease with which people can create a mental map so that the spatial structure of a place can be understood and navigated as a whole.

**Local value recycling**: Reinvestment of revenue generated by a development in that same development, to further increase asset value and positive socio-economic impacts.

**Market potential value**: Unrealized market value of a station area, sometimes measured through a composite index considering major drivers of demand, including current and future human densities, current and future number of jobs accessible within 30 minutes by transit, and major drivers of supply (including the amount of developable land, potential changes in zoning, and market vibrancy).

**Mixed-use development**: Pattern of development characterized by diversified land uses, typically including housing, retail shops, and private businesses, either within the same building space (vertical mixing) or in close proximity (horizontal mixing).

**Node value**: Measure of importance of a public transit station based on passenger traffic volume, intermodality, and centrality within the network; measured through a composite index.

**Opportunity Areas**: London’s major source of brownfield land. Most can accommodate at least 5,000 jobs, 2,500 new homes, or a combination of the two, along with other supporting facilities and infrastructure.

**Pareto distribution**: Inverse power law probability distribution used in the description of social, scientific, geophysical, actuarial, and many other types of phenomena.
Sometimes referred to as the Pareto principle or the 80–20 rule, which states that 20 percent of a given statistical population represents 80 percent of the total value.

**Permeability**: Extent to which urban forms permit the movement of people or vehicles in different directions.

**Place value**: Determinants of the attractiveness of a place, including amenities; schools; health care facilities; type of urban development; local accessibility to daily needs by walking and cycling; quality of the urban fabric around the station, in particular its pedestrian accessibility; small size of urban blocks and fine mesh of connected streets, which create vibrant neighborhoods; and mixed pattern of land use. It is measured through a composite index.

**Population density**: Number of people living in an urban area divided by the land area.

**Power law**: Functional relationship between two quantities in which one quantity varies as a power of another. The distributions of a wide variety of physical, biological, and manmade phenomena approximately follow a power law over a wide range of magnitudes. Quantities following power laws lack well-defined average values, making it incorrect to apply traditional statistics that are based on variance and standard deviation (such as regression analysis). Appendix A shows that most quantities in urban space (densities, network centralities, economic productivity, and so forth) that are the core indicators for applying the 3V Framework are not distributed around average values but follow power laws.

**Public-private partnership (PPP)**: Formal partnership between a public sector entity and a private corporation often used to construct and operate infrastructure facilities or develop certain urban areas.

**Public realm**: Publicly owned streets, pathways, rights of way, parks, publicly accessible open spaces and any public and civic building and facilities.

**Redevelopment/regeneration**: Type of development that seeks to reinvest in already developed areas, typically targeting parcels that are underutilized, such as vacant or abandoned properties.

**Transit-adjacent development (TAD)**: Development located near a transit node that fails to leverage on such proximity because it lacks key characteristics of transit-oriented development, such as pedestrian-friendly development or mixed use.

**Transit-oriented development (TOD)**: Planning and design strategy to ensure compact, mixed-use, pedestrian- and bicycle-friendly, and suitably dense urban development organized around transit stations. TOD embraces the idea that locating amenities, jobs, shops, and housing around transit hubs promotes transit usage and nonmotorized travel. Well-planned TOD is inclusive and integrates resilience to natural hazards.
**TOD typology:** Tool for prioritizing where and when to make investments, determining the types of investments that are appropriate in different communities, and guiding the timing and scale of those investments. Provides a means of classifying and differentiating transit communities in a city by grouping them based on shared characteristics. A TOD typology aims at creating an aspirational vision of future land uses, prioritizing stations for investment, providing guidelines and actions for implementation, and measuring performance on a range of metrics.

**Transit core:** 400-meter radius area immediately surrounding a premium transit station.

**Transit neighborhood:** 800-meter radius area surrounding a premium transit station.

**Transit supportive area:** 1.6 kilometer-area immediately surrounding a premium transit station.

**Transfer of development rights:** Ability to buy and sell air rights (within the limit of their floor area ratio allotment or the unused development rights that remain when a building does not use up its FAR allotment). Typically applies only to certain parcels that often can be transferred only to specific “receiving” parcels.

**Urban block:** A city block, urban block, or simply block is a central element of urban planning and urban design. A city block is the smallest area that is surrounded by streets. City blocks are the space for buildings within the street pattern of a city. They form the basic unit of a city’s urban fabric.

**Urban fabric:** Physical aspect of urbanism, including building types, thoroughfares, open space, frontages, and streetscapes.

**Urban morphology:** Study of the form of human settlements and the process of their formation and transformation that seeks to understand the spatial structure and character of a metropolitan area, city, town or village by examining the patterns of its parts and the process of its development.

**Urban realm:** Spatial components of a metropolis.

**Value capture finance:** Appropriation of value generated by public sector intervention and private sector investment in relation to an underused asset (land and/or structure) for local reinvestment to produce public good and potential private benefit.

**Zoning:** Control by authority of use of land and the buildings on it. Areas of land are divided into zones within which various uses are permitted. Zoning aims to promote orderly development and to separate incompatible land uses, such as industrial uses and homes, to ensure a pleasant environment.
Introduction

Transit-oriented development (TOD) is a planning and design strategy for achieving compact, mixed-use, pedestrian- and bicycle-friendly urban development closely integrated with transit stations. It embraces the ideas that locating amenities, jobs, shops, and housing around transit hubs promotes transit use and non-motorized travel and that careful place-making softens the perception of density and facilitates the emergence of vibrant communities. It can be applied to metropolises like Hong Kong SAR, China, as well as smaller cities like Copenhagen, a municipality of about 592,000 people.

Benefits of Transit-Oriented Development

Making Cities More Competitive, Raising Real Estate Values, and Contributing to Growth

Transit-oriented cities are more competitive than other cities, as a result of agglomeration effects. Doubling job density increases economic productivity by 5–10 percent (Salat and others 2017). In New York, the world’s most competitive global city, 60 percent of office space is agglomerated on only 9 square kilometers (1 percent of the city’s land area) (Salat 2017). This concentration offers opportunities to reinvent urban spaces with high-quality public and green areas. Copenhagen and Stockholm (box I.1), both of which have embraced TOD principles, rank among the world’s top cities in terms of per capita GDP, the Green City Index, and the UN-Habitat City Prosperity Index (UN-Habitat 2015).

TOD increases and concentrates real estate value in the best-connected areas. Since 1996 the growth of home values in TOD neighborhoods in the United States has outpaced the growth of home values nationally by a margin of nearly 2 to 1; in 2014 the average home in a TOD neighborhood was worth 3.5 times more than the average home (Infrastructure USA 2015).

Cities like Hong Kong SAR, China; London; New York; and Tokyo capture part of these increases in value and use it to finance additional enhancements of infrastructure and the public realm, creating a positive feedback loop between development and urban growth. For example, the rail plus property model in Hong Kong, SAR China brought in about HK$140 billion in revenues between 1980 and 2005 and unlocked land for 600,000 public housing units (McKinsey Global Institute). Part of this value capture can be used for social housing in well-connected areas to counterbalance the negative impacts of gentrification and preserve access for all.

Opposite page:
Copenhagen has been planned according to TOD since 1947. It is the first city to target becoming carbon neutral by 2025, and ranks second worldwide in UN Habitat City Prosperity Index. Source: © Françoise Labbé. Used with the permission of Françoise Labbé. Further permission required for reuse.
Transforming the Urban Space

Saving People Time and Money

Transport and housing are traditionally the largest expenditures for households, often accounting for more than half of their income. Inclusive TOD plans for low-income and affordable housing near mass transit stations enhance access to job opportunities for all. In the United States, people living near TOD stations spend 37 percent of their income on transport plus housing against 51 percent for other people (Reconnecting America 2009).

Reducing Greenhouse Gas Emissions and Increasing Resilience to Natural Hazards

TOD can reduce infrastructure costs and CO$_2$ emissions per unit of activity (ESMAP 2014). Hong Kong SAR, China, for example, increased gross value added per capita by 50 percent between 1993 and 2011 while reducing its CO$_2$ emissions for transportation per capita and road gasoline consumption per capita by about 10 percent (Rode and others 2013). Copenhagen and Stockholm also achieved this decoupling.

TOD can also make cities more resilient to natural hazards than other kinds of development if implemented strategically. Because TOD leads to a concentration of activities and housing at the city level, it allows cities to locate such areas of high density in lower-risk zones, address risks in those areas more systematically, ensure that peak concentration occurs primarily in areas with high levels of network redundancy, and turn those areas into well-connected refuge zones in case of emergency.

Principles of Transit-Oriented Development

The World Bank’s TOD Community of Practice is a group of transport, urban, social, and land specialists working in or with the World Bank on TOD projects. It has

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**BOX I.1** Transit-Oriented Development in Stockholm

The growth of Stockholm’s built-up area has generally followed the city’s main public transport corridors. Over the decades, the containment of urban development along these corridors has ensured a threshold level of density that has facilitated a public transit–oriented transport system. Even over the last 10 years, Stockholm’s containment index—which measures the growth of population within the city core compared with growth within the outer belt—has remained positive.

Within the Organisation for Economic Co-operation and Development (OECD), Stockholm’s urban containment is second only to London; its long-term growth, levels of wealth, and rates of productivity are among the highest in the OECD. Stockholm’s metropolitan economy, measured as gross value added per capita, grew 41 percent from 1993 to 2010. Over the same period, greenhouse gas emissions per capita decreased 35 percent, to 3.5 tCO$_2$e (Floater and others 2013).
summarized eight key principles for implementing TOD, based on international experience in TOD:

1. Align human densities, economic densities, mass transit capacity, and transit network characteristics for greater accessibility.
2. Create compact regions with short commutes.
3. Ensure the resilience of areas connected by mass transit.
4. Plan and zone for mixed-use and mixed-income neighborhoods at a corridor level.
5. Create vibrant, people-centric public spaces around mass transit stations.
6. Develop neighborhoods that promote walking and cycling.
7. Develop good-quality, accessible, and integrated public transit.
8. Manage demand for private vehicles.

Transit-Oriented Development at the City and Station Level

Many rapidly growing developing countries are investing massively in transit systems. China, for example, adds on average 450 subway stations every year. By 2020 Beijing will have 1,050 and Shanghai 970 kilometers of subways, making their networks among the longest in the world. In India, cities are constructing more than 600 kilometers of metros and planning another 250 kilometers.

The best-planned cities set specific objectives quantifying how such systems will connect households to jobs and services and provide the backbone for peak-hour transport. Singapore’s masterplan targets for 2030 include ensuring that 8 in 10 households live within a 10-minute walk of a transit station, 85 percent of public transport journeys are completed within 60 minutes, and 75 percent of all journeys in peak hours are undertaken on public transport (LTA 2013). Such accessibility targets provide clear guidance to transport, land, housing, and economic agencies and require them to work together, because the targets can be achieved only through combined and aligned interventions.

Concentrating development in the one-kilometer radius around transit stations offers a unique opportunity to shape cities and make them more livable, efficient, and inclusive. Cities can take supportive measures to prioritize development around stations. They can take as a core performance benchmark the percentage of jobs and residents within one kilometer of mass transit stations and the percentage of new development taking place in those well-connected areas as opposed to other parts of the city. They can support such concentration by placing priority on new public infrastructure in those well-connected areas while restricting development in other areas. At the level of corridors, cities can encourage greater economic opportunities by supporting a mix of uses and income groups. Around stations, cities can facilitate the creation of health, education, shopping, and recreation facilities to enable communities to thrive locally. Such approach has long-term impact on reducing energy consumption, CO₂ emissions, and transport cost as a share of GDP.

However, not all stations are equal in terms of development potential. The number differs from city to city, but generally about 15 percent of station areas are
expected to achieve very high densities (World Bank and Development Research Center of the State Council, P.R. China 2014). Other areas may not have the commercial value required for such development.

**Typologies for Identifying Where, When, and How to Create Economic Value**

There is no one size fits all to TOD throughout a city. Early projects often focus on greenfield sites, where development is easier, or at central locations and highly accessible transit hubs, where high-density development is supported by high land value. But other types of opportunities exist outside these major areas. They require tailored approaches.

Understanding where, when, and how potential value can be created requires tools that help differentiate the opportunities offered by different stations in a mass transit network. Improving transit at a location creates conditions favorable to its development. In turn, development of a location creates conditions favorable to the further development of the transport system.

A TOD typology differentiates transit station areas based on their suitability for accommodating growth. It links regional and local public policy recommendations to support the type of development that is best suited for a specific site and community. A TOD typology aims at creating an aspirational vision of future land uses, prioritizing stations for investment, providing guidelines and actions for implementation, and measuring performance on a range of metrics.

**Traditional Transit-Oriented Development Typologies**

Academics have long developed TOD typologies based on their observations of past TOD development in cities. Bertolini (1999) introduced a node/place model (see chapter 3) seeking to explore the underlying relationships between node and place values, with a focus on station areas. Such model was further supported by the transport land use feedback cycle developed by Giuliano (2004), Meyer and Miller (2001), and Wegener and Fuerst (1999). Cervero and Murakami (2008) developed a typology drawing on the experience of Hong Kong SAR, China; Singapore; and Tokyo.

More recently, cities have developed such typologies to support their strategic planning. Baltimore developed a typology to identify and assign station area investment needs to a broad range of TOD actors and stakeholders (CTOD and others 2009). Its plan was folded into a broader TOD strategic plan that has enabled Baltimore to fund transit-supportive projects more systematically rather than through a usual piecemeal approach.

Denver created a typology to provide a vision (Transit-Oriented Denver) for the appropriate density and land use mix in each of the city’s existing and planned light rail station areas. Its plan served as a guide for subsequent detailed station area planning studies.

Portland developed a typology for identifying overall needs related to implementing TOD regionwide and determining where TOD development is most ap-
appropriately (CTOD and Nelson/Nygaard n.d). The typology and recommendations of the cost-effectiveness model helped evaluate not only where investments should be made but what types of investment made most sense. Portland’s typology strives to leverage opportunities by strategically targeting TOD investments and helping public agencies and programs with an interest in TOD understand the types of investments that are appropriate given variable local physical and market contexts. It aims to ensure an investment response to changing market cycles and variable local market conditions.

**Going Beyond Traditional Typologies: The 3V Framework**

The 3 Value Framework, or 3V Framework, generalizes these international approaches based either on the node/place model or a market/place model (such as the Baltimore and Portland typologies) by identifying the three values that can characterize a transit station:

- **Node value** describes the importance of a station in the public transit network based on its passenger traffic volume, intermodality, and centrality within the network. Node value is measured through a composite index.

- **Place value** describes the urban quality of a place and its attractiveness in terms of amenities, schools, and health care; the type of urban development; local accessibility to daily needs by walking and cycling; the quality of the urban fabric around the station, in particular its pedestrian accessibility, the small sizing of urban blocks, and the fine mesh of connected streets that create vibrant neighborhoods; and the mixed pattern of land use. Place value is measured through a composite index.

- **Market potential value** refers to the unrealized market value of station areas. It is derived through market analysis (the study of demand and supply). It is measured through a composite index that includes major drivers of demand including current and future human densities (residential plus employment); the current and future number of jobs accessible by transit within 30 minutes; and major drivers of supply, including developable land, potential changes in zoning (such as increasing floor area ratios (FARs)), and market vibrancy. The approach looks forward rather than backward.

The 3V Framework is a methodology for identifying economic opportunities in areas around mass transit stations and optimizing them through the interplay between the node, place, and market potential values. It provides a typology to cluster stations based on the three values. It equips policy and decision makers with quantified indicators to better understand the interplay between the economic vision for the city, its land use, its mass transit network, and its stations’ urban qualities and market vibrancy. It outlines planning and implementation measures for the different clusters of stations that can help prioritize limited public resources and create value through coordinated interagency measures.

Such analysis enables a city to develop and communicate a vision that articulates development around its mass transit network and facilitates the alignment of TOD strategies at the metropolitan, city, network, and local levels. The 3V Frame-
work can be used to engage with citizens, private developers, investors, financiers, companies, and other stakeholders to develop, refine and advance such a vision and update it regularly. On the basis of such a vision, cities can develop plans to provide the necessary infrastructure to support higher densities in priority areas and analyze the economic returns of different programs, considering all related social and environmental aspects, responding in particular to the challenges of equitable urban growth.

**Applicability of the 3V Framework**

The 3V Framework is applicable to large cities with extensive networks and smaller cities with only a few mass transit lines or a bus rapid transit system. The model works for growing cities and declining ones. It seeks to determine the relative areas of potential within a city rather than across cities.

The examples presented in this book are mostly urban regeneration of previously stagnant areas (King’s Cross, Hudson Yards, the redevelopment of docklands in Sweden). In all of these settings, planners spurred urban growth at the local scale, using a strategy that could be applied at a larger scale to foster growth in declining cities through urban catalysts.

The 3V Framework presents two main interests for policy makers. First, it allows them to build a typology of stations that classifies all stations in a mass transit network into clusters, to which different development strategies can then be applied.

Second, the framework allows policy makers to identify the imbalances between connectivity, accessibility, place quality, and market potential values at a given station by plotting those across the three values (figure I.1). Addressing these imbalances creates high potential for economic value creation—by, for example, creating place value around an important connective node or bringing additional connectivity to a booming area. Quantification allows the various government agencies deal-
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ing with urban, transport, and economic planning to start a conversation and to synchronize high peaks of node value (major connecting hubs) with high-quality place-making to create spikes of market potential value (figure I.2).

Several levers can be used to increase individual node, place, and market potential value (table I.1), keeping in mind that the greatest impact is achieved when addressing imbalances between those values.

Structure of this Book

The book comprises a glossary, a foreword, an introduction, eight chapters, a conclusion and two appendices. The first four chapters explain the 3V Framework and how it applies to TOD strategies in different contexts and at different geo-

TABLE I.1 Levers to Increase Node, Place, and Market Potential Values

<table>
<thead>
<tr>
<th>Type of value</th>
<th>Policy lever</th>
</tr>
</thead>
<tbody>
<tr>
<td>Node</td>
<td>• Increase the number of hubs and the number of lines/modes they connect to.</td>
</tr>
<tr>
<td></td>
<td>• Interlink neighboring stations into clusters.</td>
</tr>
<tr>
<td></td>
<td>• Increase accessibility for all within the network.</td>
</tr>
<tr>
<td>Place</td>
<td>• Increase compactness (proximity to existing urban activity and short travel time to main destinations).</td>
</tr>
<tr>
<td></td>
<td>• Increase the diversity of uses.</td>
</tr>
<tr>
<td></td>
<td>• Increase the concentration of commercial, cultural, and educational amenities.</td>
</tr>
<tr>
<td></td>
<td>• Design neighborhoods that promote walking and cycling.</td>
</tr>
<tr>
<td></td>
<td>• Create a vibrant public realm.</td>
</tr>
<tr>
<td>Market potential</td>
<td>• Increase residential density.</td>
</tr>
<tr>
<td></td>
<td>• Increase job density.</td>
</tr>
<tr>
<td></td>
<td>• Increase human density.</td>
</tr>
<tr>
<td></td>
<td>• Increase the diversity of land parcels to create a vibrant land market.</td>
</tr>
<tr>
<td></td>
<td>• Increase floor area ratios.</td>
</tr>
</tbody>
</table>
Transforming the Urban Space

graphical scales. Chapter 1 describes TOD strategies at the metropolitan, network, and local levels to address the challenges of urban growth and inclusiveness. Chapter 2 details the drivers, policies, and strategies to increase values with the 3V Framework. It identifies the main policy levers and describes how planners can cluster stations according to their values and develop contextualized policies for different types of stations. Chapter 3 describes the interplay of values and the contribution a better alignment between those values can play. It analyzes the positive feedback loop of value creation and capture that can be initiated through public and private investments in underutilized assets. Chapter 4 describes in more detail one key lever of value creation: good urban design of the public realm.

Chapters 5–8 are detailed case studies. Chapter 5 describes the strategies applied to redevelop the massive Hudson Yards project, in New York. Chapter 6 describes King’s Cross, an urban regeneration project in an area of London with exceptional connectivity that was once a railyard land. Chapter 7 examines the new subway line in London (Crossrail), showing the differentiated strategies used to increase place and market potential value depending on the location and centrality of stations in relation to the London subway network and its economic cores. Chapter 8 shows how the 3V Framework can be applied to integrating the space economy of an entire city (Zhengzhou, China). It highlights the potential misalignments between the increases in accessibility and centrality created by investments in the subway network and the projected decentralization of people and jobs at the periphery of the city in areas less accessible by subway.

Two appendices complement these chapters. Appendix A describes how mathematical regularities (power laws) structure the distribution of urban values across urban space, network centralities, and the intensity of passenger flows in stations and commuting lines. Appendix B provides definitions and calculation formulas for the key metrics of each value.

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Transit-Oriented Development Strategies at the Metropolitan, Network, and Local Levels

By 2050 the world urban population is expected to nearly double, making urbanization one of the most transformative trends of the 21st century. Such transformation will place a high demand on new infrastructure and good planning to address the challenges many cities face in terms of pollution, congestion, and social inequity.

Rapidly growing cities can learn from cities that applied transit-oriented development (TOD) principles in shaping their urban space and transport network at the metropolitan, city, network and neighborhood levels. They can create urban spaces able to accommodate hundreds of thousands or even millions of new citizens of different income levels in a way that offers high accessibility to jobs city-wide. They can design their mass transit network to match the diverse densities in jobs and housing across the urban space. They can build thousands of new compact communities with amenities, services, and good-quality environment centered on rail, subway, urban rail, and bus rapid transit stations. Cities that have followed such TOD principles have managed to spur economic growth, contribute to inclusive development, and decouple their economic growth from their transport greenhouse gas emissions per capita.

The Global Infrastructure Challenge and the Risks of Uncoordinated Urban Growth

Cities will accommodate up to 2 billion more people in the next 30 years. An estimated 177 new cities with more than 1 million inhabitants will emerge (United
Nations 2014). As witnessed over the past two decades throughout the world, in particular in Asia (World Bank 2015), this urbanization is likely to be accompanied by a rapid expansion of urban land, with a potential trebling of urban land in developing country cities between 2005 and 2030 (Shlomo, Sheppard, and Civco 2005).

The McKinsey Global Institute (2013) estimates the cost of global infrastructure between 2013 and 2030 at $57 trillion (3.5 percent of global GDP)—$3.2 trillion a year simply to keep up with projected global GDP growth. An estimated 40 percent of these needs consist of transportation infrastructure (roads, rail, ports, and airports). The center of gravity of this global infrastructure spending has already shifted to developing economies and cities, following the path of economic growth.

Funding the world’s infrastructure needs is likely to become more difficult for a variety of reasons. The growing level of indebtedness since the 2008 financial crisis will place constraints on public sector budgets. More volatile resource prices have made long-term budget planning more complex for many developing countries. At the same time, countries face additional costs to make their infrastructure resilient to climate change.

Well-planned cities are engines of growth. Urbanization therefore presents an opportunity to lift hundreds of millions of people out of poverty. But rapid and fragmented urban growth can adversely affect economic output, by reducing potential and actual economic agglomeration, increasing inequalities in housing and access to jobs, and raising infrastructure costs. Worse still, it can lock cities into inefficient paths of dependence on high resource consumption and low productivity combined with severe externalities like congestion and pollution.

**Impacts of Transit-Oriented Development**

TOD is a policy framework for urban spatial development with long-term structural impacts. Transport infrastructure is the single most important determinant of urban expansion; land-use patterns, in turn, directly shape mobility behavior (LSE 2013). Land-use and transport policies are central tools for city governments; they should be better integrated, in order to enable agglomeration economies through better job matching, knowledge sharing, and networking opportunities (Cervero 2001; Fallah, Partridge, and Olfert 2011); reduce carbon emissions and resource use through efficient public transit; and improve social inclusion with more accessible urban form.

The actions of a multiplicity of stakeholders and consistent policy frameworks across many geographical scales are needed to leave a long-term positive impact on city form and maximize economic efficiency. One city that has been successful in doing so is Copenhagen, which has shaped its urban form and achieved high levels of green growth through TOD (box 1.1).

Living near public transit saves both time and money. TOD planning can enhance social inclusiveness at the city level by increasing accessibility to jobs, particularly for the urban poor, as New York has done (box 1.2). TOD planning allows policy makers to consider both transportation and housing costs by developing inclusionary housing policies (box 1.3). In Portland, for example, combined hous-
BOX 1.1 Promoting Green Growth in Copenhagen through Transit-Oriented Development

Copenhagen’s “Finger Plan” links the municipality with the surrounding region, promotes urban growth along rail corridors radiating from the city center, and protects “green wedges” from development. First proposed in 1947, it received renewed regulatory support at the national level through the 2007 Danish Planning Act. The Act endorsed the station proximity principle, which requires most new offices of more than 1,500 square meters to be located within 600 meters of a railway station. Regulation of retail development promotes the location of stores in town centers by restricting their size and specifying the location of town centers where retail development is permitted. City-level land-use planning stimulates mixed-use, high-density development around stations and limits parking provisions.

In the 1990s, rail expansion was built in advance of demand to steer growth along desired transit corridors. In this way, Copenhagen was able to help developers identify which areas to prioritize in development.

TOD has led to the development of dense, walkable urban centers connected by rail-based public transit. Box map 1.1.1 shows the concentration of activities in the city center and along rail corridors. The radial links separated by green wedges give shape to the city’s metropolitan structure.

Copenhagen has seamlessly linked transit, cycling, and walking facilities. One-third of
BOX 1.1 Promoting Green Growth in Copenhagen through Transit-Oriented Development (continued)

suburban rail-users use bicycles to access stations. Investments support urban regeneration, city-center densification, and public realm improvements.

About 36 percent of all trips to work or educational institutions in Copenhagen were by bicycle in 2008–10 (compared with 2 percent in London and 7 percent in Stockholm). This high modal share is a key element in the declared goal of making Copenhagen CO₂-neutral by 2025. Copenhagen’s overall goal for cycling includes goals for the number of cyclists as well as the quality of cycling (sense of security, safety, travel time, and comfort). The city now has almost 370 kilometers of dedicated cycle lanes. It has integrated cycling with the public transit network and implemented various information, training, and safety initiatives. Copenhagen aims to be the world’s best bicycle city and has set a target that 75 percent of all trips be by foot, bicycle, or public transit by 2025.

Measured by gross value added per capita, Copenhagen’s metropolitan regional economy grew 30 percent between 1993 and 2010. Over the same period, transport-related carbon emissions decreased by 9 percent, to 0.76 tCO₂ per capita (box figure 1.1.1). Sprawling Houston spends about 14 percent of its GDP on transport; Copenhagen spends just 4 percent (Floater and others 2014).

BOX FIGURE 1.1.1 Green Growth in Copenhagen, 1993–2009
New Yorkers rely on public transportation more than residents of any other U.S. city. Indeed, 56 percent of New York trips to work are made on public transit; the average for the next 10 largest U.S. cities is just 11 percent.

New York’s public transit fuels economic growth. The average New Yorker can reach more than 1.4 million jobs, or nearly 40 percent of payroll jobs, using public transit in 45 minutes (Rudin Center 2015). Although average access to jobs by public transit is high, differences across neighborhoods are significant. High housing prices push low-income people to neighborhoods far from job centers. In more than half of the city’s neighborhoods with below-average household income (home to some 2.3 million residents), the number of jobs accessible by transit is below average.

For achieving greater equality, the city targets a 25 percent increase in transit access to jobs for all New Yorkers by 2030 and is focusing on neighborhoods in which job access is particularly low by ensuring that 90 percent of New Yorkers can access at least 200,000 jobs within 45 minutes. New public transit and growing jobs in the outer boroughs will help close this gap.

New York’s plan features initiatives to improve jobs access for New Yorkers in four main ways:

- Supporting the growth of jobs closer to housing.
- Preparing New Yorkers to access more jobs through workforce development opportunities.
- Creating and preserving housing close to jobs and transit.
- Improving transit connectivity by expanding the city’s Select Bus Service network with free transfer between bus and subway services, creating a citywide ferry network, and supporting other system-wide investments.

Source: City of New York 2014a and b.
ing and transportation costs are lower around station areas (40 percent of income) than in the Portland region as a whole (50 percent) (Center for Transit-Oriented Development 2011).

**Transit-Oriented Development Strategies at the Metropolitan/City Level**

International experience suggests that the intensity of land use should not be evenly distributed across the city but should instead peak where accessibility to jobs is greatest. Firms locate where they can increase their productivity through agglomeration and localization effects (Salat 2017). Manufacturing firms locate where they can connect to large logistics infrastructure and land is cheap. In contrast, providers of high value added activities (finance, research and development, professional services) locate where they can access large number of similar firms. In Manhattan, for example, 60 percent of all office space is concentrated in only 9 square kilometers (1 percent of land area), despite high land and real estate prices (Salat 2017).

High concentrations of economic activity foster local economic development through economies of urbanization and localization (Rosenthal and Strange 2004), which attract skilled workers and more productive entrepreneurs and firms (Behrens, Duranton, and Robert-Nicoud 2014). Higher densities of people and firms allow for ideas to flow, giving birth to innovation. Density also allows firms to benefit from economies of scale and links to input and product markets. Research shows that doubling job density increases economic productivity by 10 percent (Salat 2016).

Agglomeration economies made London outperform the rest of the United Kingdom in terms of economic productivity in 2015—something it did not do in the 1990s. On only 0.2 percent of Greater London’s land area, the Square Mile of the City of London produces 14 percent of the city’s GDP—equivalent to 3 percent of the United Kingdom’s total economic output. Job density in the Square Mile increased 30 percent in the last 10 years, to 150,000 per square kilometer. As a result, productivity per job in the Square Mile is twice that of Greater London and three times that of the United Kingdom (Salat 2017). The quality of public transit connections has a strong effect on business location choices in Central London (Sivaev 2013).

Job concentration in the city core and a dense urban form aligned with the transit network are key factors of competitiveness (Jenks, Burton, and Williams 1996). Hong Kong SAR, China, illustrates how the coordination of transit infrastructure provision, land use planning, and economic policy has shaped urban forms for economic efficiency, social inclusiveness, and environmental impacts (box 1.4).

Positive agglomeration effects concentrating jobs at high densities are driven by transit accessibility both to a large number of other jobs and other firms and to a large pool of workers. International research suggests a 30-minute threshold for these effects: People and jobs tend to concentrate at high density in areas where a high number of jobs, firms, and people can be accessed (Salat and Bourdic 2015b). Restrictive zoning policies should not constitute a barrier to these con-
BOX 1.4 Spurring Economic Growth through Rail-Based High-Density Development in Hong Kong SAR, China

Hong Kong’s spatial planning is based on rail-based development and a commitment to doing more with less. Hong Kong prioritizes regeneration of existing urbanized territory rather than expanding into greenfield areas. Regulation and guidelines specify where development can occur and at what density levels; they also limit parking. Urban expansion can occur only in strictly defined areas: 46 percent of Hong Kong’s territory has been legally protected since the 1970s as “country park”; another 30 percent of land remains undeveloped and subject to various degrees of protection under a hierarchy of no-go areas. Land is zoned according to maximum floor area ratios (the ratio of a building’s gross floor area to the size of the piece of land upon which it is built), with extremely dense building permitted directly above and adjacent to rail stations (LSE 2013) (box map 1.4.1).

This pattern of development has led to the decoupling of economic growth and gasoline consumption per capita (box figure 1.4.1). Gross value added per capita rose 50 percent between 1993 and 2011 while CO₂ emissions per capita and gasoline consumption per capita declined by about 10 percent.

The rail and metro network now encompasses 210 kilometers of track and 84 stations. The government-controlled Mass Transit Railway Corporation (MTRC) operates a unique rail plus property business model that captures the increase in property value resulting from new railway infrastructure, using revenue from property develop-
ment to fund the railway’s construction and operation. MTRC earns profits, generating cost savings for taxpayers from an unsubsidized public transit system. Passenger fares are low by international standards. The MTRC estimates direct financial benefits to the government resulting from the rail plus property program at $27 billion since the establishment of the company in the 1970s. Land value capture associated with subway development has unlocked land for 600,000 public housing units.

Integration of land use and transit planning has put 75 percent of people and 84 percent of jobs in Hong Kong SAR, China, less than 1 kilometer from a mass transit station. The city has one of the highest rates of public transit use (90 percent of motorized journeys) and lowest rates of car ownership (56 cars per 1,000 people, compared with an average of 404 in OECD countries).

Annual carbon emissions from passenger transport are 378 kilograms per person, compared with about 1,000 in European cities and more than 5,000 in Houston, Texas. Hong Kong SAR, China spends about 5 percent of GDP on motorized travel, compared with 12–14 percent in cities such as Melbourne and Houston (LSE 2013).

About 45 percent of the population lives in areas with densities of more than 50,000 people per square kilometer. This figure is close to the peak densities in New York (58,500 people per

**BOX FIGURE 1.4.1** Annual Gross Value Added, Employment, Gas Consumption, and Carbon Dioxide Emissions in Hong Kong SAR, China, 1993–2009

Source: LSE Cities. © LSE Cities. Used with the permission of LSE Cities. Further permission required for reuse.
BOX 1.4  Spurring Economic Growth through Rail-Based High-Density Development in Hong Kong SAR, China (continued)

square kilometer). Only 6 percent of the population lives in areas with less than 5,000 people per square kilometer, compared with 36 percent in London. The negative effects of density have been mitigated by good design and layout and the inclusion of open spaces and community facilities. A substantial proportion of Hong Kong’s urban population does not view high density as a problem. Indeed, many people prefer the presence of a large number of people (Yeh 2011).

High density creates more efficient land use, makes it easier to provide public services and facilities, reduces energy and infrastructure costs, and maximizes the effectiveness of public transit while minimizing the distance between sites of day-to-day activities. It also supports agglomeration economies, including access to a large pool of skilled labor within easy commuting distance. The high density of firms in the inner city improves networking opportunities and knowledge spillovers. Such interactions in the advanced services sector have helped Hong Kong SAR, China, secure its position as the third global financial hub, after London and New York.

Source: Based on LSE 2013.

centrations or to densification of the most accessible urban areas around the most important and most central transit stations. Box 1.5 shows how transit accessibility to a large number of jobs determines firms’ locational choices in Paris.

This book underlines the agglomeration benefits of concentrating jobs in the city core, but the city core in large cities is often based on compact polycentric development.

In London, New York, and Tokyo, the core is made of several growing subcenters linked by transit. The case studies on London describe subcenters like King’s Cross (considered a fringe location by London planners) and Canary Wharf (about a 20-minute transit ride from the City of London). In New York they include Midtown, Lower Manhattan, Downtown Brooklyn, and Long Island City. In Tokyo, the Yamanote line links a ring of rapidly growing subcenters along a 33-kilometer circle line around Tokyo.

Transit-Oriented Development at the Network Level

The layout of transit networks, often in the form of a core-and-branch system, plays a key role in shaping forces of agglomeration and the distribution of densities across the urban space. Network analysis shows the benefits of developing subcenters around stations at the intersection of inner subway networks and suburban rail stations, because they concentrate passenger flows and have high growth potential. Such approach also supports the polycentric development of cities.

In the cities profiled in this book, two-thirds of jobs are typically located outside the core area, providing opportunities for creating mixed-use development around
BOX 1.5 Access to and Location of Jobs in Paris Based on Transit

More than 1.5 million jobs can be reached in Paris in less than 30 minutes in areas well connected by transit. This number falls to less than 100,000 jobs in poorly connected areas (box map 1.5.1). The best-connected areas correspond roughly to the Paris of 1859, showing the spatial permanence of city structures once established. Firms locate preferentially where prospective employees can reach them easily (box map 1.5.2).

BOX MAP 1.5.1 Number of Jobs in Paris Accessible by Public Transit in Less than 30 Minutes, 2015

Source: © Urban Morphology and Complex Systems Institute. Used with the permission of UMCSII. Further permission required for reuse. Data from INSEE and RATP.

stations that are not fast-growing core stations. Jobs and social activity are concentrated near transit stations along the branches radiating from the core of the subway network and benefit from multimodal integration. The intensity of human development and the job/housing ratio are higher closer to the network core, which corresponds well with the 3V Framework model. The effectiveness of such network is reinforced through concentrated development around stations, ensured through proper zoning.
Core-and-Branch Systems

Many subway systems in global cities are characterized by a core-and-branches structure (Roth and others 2012). The core is densely connected with stations at constant densities, interconnected by crisscrossing lines. It provides high levels of accessibility for people and companies. The density of stations decreases sharply moving away from the city core on branches.3

The core-and-branches layout has a strong impact on local development potential. It determines the long-term trajectory of densities and accessibilities, as highlighted in box 1.6.

The London, Paris, and Tokyo subways started their development around the same time. All three cities created a circle line (in 1884 in London, 1900–1910 in Paris, and 1885 in Tokyo) surrounding the core city (about 30 square kilometers in London, 45 square kilometers in Paris, and 60 square kilometers in Tokyo).
The Paris subway opened in 1900. Its circle line, built between 1900 and 1910, still defines the limits of the 45-square kilometer core, where 1.5–2 million jobs are accessible by transit within 30 minutes. This area corresponds to the limits of Paris before the annexations of 1859. Early decisions about the subway network layout have shaped the city form and the distribution of its economic densities.

The distribution of stations within successive concentric circles shows a dense central core with an almost constant density of stations within the five-kilometer radius of the center of Paris (box map 1.6.1). Density then declines rapidly beyond the core, following a power law ($R^{-1.63}$) (where $R$ is the distance from the center).

Job (box map 1.6.2) and population (box map 1.6.3) densities are also denser within the three-kilometer radius of the 1910 subway circle line. These densities decrease less sharply than the density of subway stations when crossing the core, resulting in a decrease in accessibility to transit and an increase in car dependency beyond the subway core.

In the maps below, the black line delineates the city of Paris including the woods of Boulogne and Vincennes (total municipal area of 105 square kilometers). The red lines are the future lines of the major subway extension in the low-density suburbs (Grand Paris Express 4 lines totaling 200 kilometers).
BOX 1.6 Transit, Job, and Population Densities in Paris (continued)

BOX MAP 1.6.2 Job Density in Paris per Square Kilometer, 2015

Source: © Urban Morphology and Complex Systems Institute. Used with the permission of UMCSI. Further permission required for reuse. Data from INSEE and RATP.

BOX MAP 1.6.3 Residential Density in Paris per Square Kilometer, 2015

Source: © Urban Morphology and Complex Systems Institute. Used with the permission of UMCSI. Further permission required for reuse. Data from INSEE and RATP.
From this circle line, branches of suburban rail radiate into the suburbs. The density and interconnectedness of stations is high in the network core and low in the branches, creating job and economic hyperdensities in the core. Network layouts shape densities—or put another way, cities are networks from which locations emerge.

The core-and-branches structure of most subway networks leads to concentration of jobs within the core. In London, for example, one-third of all jobs (1.5 million) are concentrated in the 15-square kilometer hypercore, the most accessible and central part of the subway network.

**Polycentric Systems**

Most subway systems are polycentric, with a ring of strong economic subcenters along the loop line (the Yamanote line in Tokyo is one example). Seoul’s subway network, inaugurated in 1974, 90 years after London Circle line, is less concentrated and more grid-like, encouraging the emergence of subcenters such as Gangnam-gu.

TOD planning encourages the intensification of human density (people and jobs) with a good job/housing mix around the most connected transit stations outside the core while preventing development in the less accessible areas between the branches. As a complement to the core, polycentric centers linked via transit avoid creating one-way flows at peak work hours. China Development Bank Capital, Energy Innovation, and Energy Foundation (2015) recommends that the job-resident ratio (the number of people employed divided by the number of residents) should be 0.5–0.7 in every commuting district and the area should not exceed 15 square kilometers.

**Multimodality**

When choosing new line layouts, planners need to pay attention to enhancing the connective strength of the entire network, the hierarchy of its centralities, and its alignment with economic concentrations. Effective transit systems are hierarchically integrated in terms of service, fares, and information; they combine mass transit options for the densest corridors, regular bus services for lower-density corridors, and last-mile connectivity solutions at the neighborhood level. In large emerging cities spilling across multiple local governments (such as the Lima metro area or mega-urban regions such as the Yangtze Delta River), doing so requires the creation of regional agencies to ensure coordination of infrastructure investment across multiple jurisdictions.

Multimodality across scales—that is the seamless combination of different transport modes for a given trip—creates strong hubs that connect urban, regional, national, and even continental scales. London’s Crossrail provide new transport links with the Tube, Thameslink, the National Rail, the Docklands Light Railway (DLR), and the London Overground. More than 200 million passengers are projected to use Crossrail in its first year of operation in 2019. Crossrail station interchanges with Tube stations and high-speed rail lines (the existing HS1 and the planned HS2) will create very high node values, spurring urban development to
align place value with the very high node values of the most central stations. Main hubs where jobs are already concentrated will have more connections and more lines after Crossrail becomes operational. These hubs, which sit atop the London transit system hierarchy, are clustered. Crossrail will provide a direct connection between all of London’s main business centers, linking Heathrow with Paddington, the West End, the City, and Canary Wharf. Reductions in travel times, improvements in passenger experience, and increases in the frequency of rail service will have significant impacts on London’s economic performance. New residential and commercial investment is expected to have a transformational effect on key locations along the route.

**Zoning Around Stations**

To reap the benefits of investment in transit networks, cities encourage development at major interchanges, at the most accessible stations in the network, and at stations that are major articulations in the network; moderate development in areas that are less accessible; and discourage development in areas that are more than 1 kilometer from a subway station. This approach is central to the achievement of city-level accessibility targets.

Zoning policies can be fine-tuned to coordinate the provision of transit infrastructure and the development of land. An effective planning instrument for achieving optimal land use intensity at city level and around transit stations is the floor area ratio (FAR), also known as the floor space index (FSI), the site ratio, and the plot ratio.

Good practice includes setting FARs at different levels depending on uses and accessibility. In Manhattan, for example, the FAR is 24.0 for highly accessible areas around Grand Central Terminal, 21.6 along Park Avenue, and 14.4–18.0 in other areas to the east and west (New York City 2013). Singapore (box 1.7) and Seoul (box 1.8) also use FARs finely tailored based on proximity to stations.

Good practice also includes a margin of flexibility for both transferring development rights between different uses as the market changes and allowing private developers to adjust the intensity of development based on market needs. In London’s Kings Cross, margins of flexibility were provided to the main developer between uses (residential, office, retail) of up to 20 percent. Such an approach increases the marketability of real estate operations in developments that take years to complete. This flexibility can also be used to capture part of the value created by real estate development to finance transit infrastructure provision, public space, and affordable housing.

Zoning in the Hudson Yards project in Manhattan sets FARs at 10–33 for predominantly commercial use, 6.5–12 for mixed use, and 6–15 for predominantly residential use. The range between base and maximum FARs is intended to provide flexibility and capture value. Developers who want to exceed the base FAR can do so by making bonus payments to the District Improvement Fund (DIF). The DIF can be used to finance subway lines extensions, public space, and inclusionary housing, creating a positive feedback loop of development (see chapter 3) from the initial rezoning at higher density and a social mix within a high-end mixed-use business district.
Local communities are the building blocks of TOD. In a TOD community, the interface between a station and the community it serves is critical. Both TOD and transport-adjacent development (TAD) focus on an 800-meter or 10-minute walk radius from a new station, but they deliver different experiences and built environ-
Like TOD, TAD is near transit. Unlike TOD, however, it fails to capitalize on this proximity. It lacks functional connectivity to transit in terms of land-use composition, station access, and site design.

Once a development is built, transitioning from TAD to TOD typically takes a major push from local government in partnership with private sector partners—and retrofitting is almost always more expensive and complex than starting with a

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**BOX 1.8 Using Zoning to Encourage High-Density Development Around Major Transit Nodes in Seoul**

Seoul’s zoning regulations set floor area ratios as high as 10 for commercial uses around the most connected and central transit stations, 2–4 for mixed residential and business areas, and 1–2 for residential uses. Uses are defined with fine granularity, depending on proximity to and the importance of transit stations (box map 1.8.1). The result is a varied city in which small residential neighborhoods abut thriving business districts and higher FARs (shown in red in the maps) are allowed near metro stations (indicated by blue circles) (box maps 1.8.2 and 1.8.3).

**BOX MAP 1.8.1 Floor Area Ratios in Seoul**

(continued on next page)
BOX 1.8 Using Zoning to Encourage High-Density Development
Around Major Transit Nodes in Seoul (continued)

BOX MAP 1.8.2 Seoul Zoning (Area Scale)

BOX MAP 1.8.3 Seoul Zoning (Neighborhood Scale)

Source: © Alain Bertaud. Used with the permission of Alain Bertaud. Further permission required for reuse.
proper TOD plan. Thus, it is important to focus at the early planning stage on the transformational effect of transit lines for delivering more vibrant, inclusive, and sustainable communities.

Part of the infrastructure investment can be financed through value capture (see chapter 3). New rail access in an area justifies higher-density planning policies, because increased accessibility will lead to higher potential market value. Many local authorities encourage more intense and diversified development near transit stations, increasing the potential for developer-funded community amenities (see chapters 5 and 6 for the description of financing instruments to capture value from developers for funding local amenities in Hudson Yards and King’s Cross).

Principles for local community development include the following:

• Embrace and maximize the quality of station design and enhance station accessibility, in order to improve the public realm for increasing place value.
• Prioritize public investment on key interventions.
• Facilitate the availability of health, education, shopping, and recreation facilities.
• Guide and leverage private sector activity.

Station-based urban regeneration or development offers great opportunities—as long as local authorities and developers adopt a proactive approach. Successful strategies that work for one station area can be replicated across the network for the same type of stations.

**Types of Stations**

Location within the network involves a complex interplay of place, network, and market potential (these concepts are defined in the introduction and developed in chapter 2). This complex interplay implies that different types of TOD should be selected depending on the location of the station within the network.

The benefits of increased transit accessibility are seldom shared uniformly across a network. Location within the network leads to a variety of local factors and planning contexts. The market potential impact of London’s Crossrail (profiled in chapter 7) varies significantly across stations, and is used for illustration below.

Every community around a station has a different market profile, a distinct set of opportunities and challenges, and a unique set of resources at its disposal. The right policy levers and delivery mechanisms for realizing regeneration and development around each station therefore vary widely.

The 3V Framework is a policy tool for clustering stations based on their different values. It allows planners to identify key experiences for station types and to use them to help determine how infrastructure projects can deliver more. TOD common principles should be adapted to different contexts with planning strategies (infill, intensification, and transformation) described in chapter 2.

**Major hubs**

The most promising type of stations are major hubs in central locations. They have a high node value because they connect several lines and urban scales. They often
have a diversified urban fabric, sometimes with unique architecture and cultural heritage that create high place value.

London’s Tottenham Court Road Station is a hub that connects the Central and Northern lines and many bus routes. Its status as a transit hub is set to grow with proposals for the Crossrail 2 route, which would see two Crossrails interchange between Tottenham Court Road and Dean Street.

Despite its high connectivity, the Tottenham Court Road locality has underperformed for decades. Crossrail unlocks the latent growth potential in the area (market potential value) by alleviating transport capacity constraints. The opportunity in this type of station is to use the new line as a catalyst for urban transformation. Doing so involves designing a more supportive street network and a better environment for pedestrians. The investments of Crossrail in the public realm also have a catalytic effect on improving low-quality building facades, which depressed the retail sector in the area and limited development values. Improvements to the built area will help create a place where a much broader range of uses can be accommodated.

**Stations at urban fringe locations**

Urban stations at fringe locations are close to the urban core but not at the most central locations. Increased connectivity acts as a catalyst to intensify activity at these stations. An example is the approach to regeneration in the area around Whitechapel station, in London (see chapter 7). Efforts in this project seek to encourage investment by restoring historic buildings and spaces to highlight cultural richness, improve ease of movement both along and across the route, and provide better walking and cycling opportunities to stimulate a healthier urban environment. The Whitechapel Vision: Regeneration Prospectus (Tower Hamlets), released in May 2015, envisions urban intensification supporting the development of 3,500 new homes and 5,000 new jobs in the community; transforming Whitechapel Road into a destination shopping area; creating seven new public squares and open spaces; and creating a world-class life science campus.

**Suburban stations**

An often-neglected type of stations are suburban stations at the end of lines. They have a low node value and in the case of Crossrail are often located within post 1950s urban infrastructures that dominate and fragment the area (which therefore has a low place value). Communities are mostly residential.

Developers and investors looking at these communities face two challenges. The first is the lack of developable sites. In the absence of a masterplan, opportunities are not obvious; they are there, they are just fragmented.

The second challenge comes from their lower market value, which that reduces the appeal for developers. Lack of developer confidence in the market means that early schemes might have to be developed in partnership with the public sector or a housing association.

An example of such a station is Abbey Road, which sits at the terminus of the southeast surface section of the Crossrail route. An infill regeneration strategy is envisioned based on diversifying uses in the community. A partnership was formed to implement a comprehensive redevelopment on a largely derelict 4-hectare
brownfield site to the north of the station. The development, known as Cross Quarter, will “develop a heart” for the area, which will include a new Sainsbury’s supermarket, addressing the lack of major convenience retail in Abbey Wood. Cross Quarter will also include 220 new homes, community facilities (including a day care and children’s center, a hotel, and units aimed at start-up businesses.

**Creating Communities**

Creating vibrant, inclusive, and sustainable communities involves much more than increasing density or designing a project. It also requires social and economic actions. The Complete Communities program launched by the Urban Land Institute defines the following goals:

- **Living**: To create and preserve communities that provide affordable housing, integrated transportation systems, and quality education.
- **Working**: To enhance regional economic prosperity through jobs, training, and access to education in a way that is designed to retain and attract new businesses.
- **Moving**: To promote increasing and improving movement around the region using public transit, electric cars, and walking and bicycling to achieve better physical well-being.
- **Thriving**: To support communities that provide access to healthy foods, arts, recreation, and entertainment that make people happy and feel meaningful through active civic engagement.

Tying urban rail projects into broader policies for community development can be mutually beneficial, significantly increasing the quality, effectiveness, and efficiency of other important areas of economic and social policy, including employment, health, education, and economic development (Jones and Lucas 2012).

All strategies for station areas redevelopment include a strong component of urban quality improvement. Good urban design adds place value, supports increased density, and helps ensure that it does not feel oppressive. It requires significant streetscape improvement, so that streets are places for people. Urban design that creates a spirit of place creates a feeling of enclosure, human scale, coherence, and linkage. (Chapter 4 discusses the core qualities of good urban design.)

**Notes**


2 An extensive body of literature examines the link between transit accessibility and agglomeration spillovers. See in particular Baird (2004); Graham (2005); Department for Transport (2006); and Targa, Clifton, and Mahmassani (2006).

3 The sharp decrease in density of stations with distance to city center follows an inverse power law of the form $R^{-1.6}$, where $R$ is the radius from the city center and $-1.6$ is the exponent (see Salat and Bourdic 2015).
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The 3V Framework is based on three values that characterize transit stations: node value, place value, and market potential value. This chapter presents key drivers of node, place, and market potential value; describes how planners can cluster station areas based on their values; and defines strategies of urban transformation to increase value. Increasing a value (node, place, or market potential) in a station area has an impact on other values. The main goal of the 3V Framework is to reveal imbalances in the structure of values across the urban space and around stations. These imbalances offer opportunities to improve the alignment of values, drive urban growth, and initiate positive feedback loops of value capture.

The 3V Framework introduces two main changes to the node/place model proposed by Bertolini in 1999. First, it bases node value on recent research about the structure of networks and the roles played by three kinds of centralities: degree, closeness, and betweenness. Network science has progressed considerably since 2000, with important discoveries about structural similarities shared by the Internet, social networks, DNA, and neural networks. This body of knowledge has been applied to subways to explain why station areas such as Shinjuku in Tokyo are booming. This work has important implications for public policies, as it reveals that network layouts matter for creating value.

Second, the 3V Framework clearly separates place value (the quality and diversity of the urban fabric) and market potential value. This separation is useful because different agencies, policies, and instruments are used to affect market and place dimensions; decision makers can clearly develop specific strategies to improve one or the other. Place and market potential value enhancements also take...
place at different stages of development—which can lead to positive feedback loops between the two—making the split particularly meaningful. The case studies on Hudson Yards (chapter 5) and Kings Cross (chapter 6) illustrate this well. In China, for example, it is essential to separate these dimensions so that decision makers realize that without addressing the use of superblocks in urban planning much value will be lost.

The 3V Framework explores different aspects of planned stations, including their role in the transit network (node value); the scale of change expected (comparing existing uses to future uses and assessing place value); and how market timing, development opportunity, and the scale of investment can come together to identify opportunity sites and key activities to support or strengthen market activity.

**What Drives Node, Place, and Market Potential Values?**

For residents, value is driven by the characteristics of a place (the fit with personal preferences in terms of urban form, schools, access to daily amenities such as parks, heath facilities, and recreation centers, walkability and bikeability) and the connections between the place and job opportunities or other amenities used less than daily in the rest of the city. For companies, value is derived from maximizing profitability, which in the service industries will typically lead to converging to space with a high agglomeration of jobs. The application of transit-oriented development (TOD) principles can support such value creation, by strengthening the quality of life at the local level while providing for enhanced job opportunities through good connections to jobs at the network and city levels using mass transit.

**Drivers of Node Value: The Impact of Centralities in the Network**

Node value is driven by the importance of a node in a transportation network. All nodes in a network are not equal. Differences in the number of lines and modes of transport a node offers, as well as differences in centrality within the network, create a hierarchy of nodes. Nodes that are strong and complex hubs, more central, more accessible, or combine all these qualities have a higher value, because they tend to serve more passengers. Shinjuku, in Tokyo—the world’s busiest station, with 3.5 million passengers a day—ranks high in terms of centrality.

*From intermodal hubs to simple nodes*

Hubs are among the most important nodes. A transport hub (also known as a transport interchange) is a place where passengers can switch between lines or between transport modes. Public transit hubs include large subway stations with multiple lines, train stations, rapid transit stations, bus stations, tram stations, and airports.

Some complex hubs combine several modes in a single integrated multimodal station, or complex of stations. Examples include Hongqiao Airport in Shanghai;
Tokyo Station, which link the high-speed rail station to six subway stations; and Union Station in Washington, which combines long-distance trains, commuter trains and buses, with metro and city buses. The number of lines and modes connecting at a hub defines its importance.

The hierarchy of nodes is as follows:

- Highly connective hubs offer transfers between many lines and transport modes. They are clustered at the core of the network.
- Core transfer stations connect two or three lines. Most are located in city centers.
- Single line stations radiate from the core of the network.

_The core-and-branches structure_

Some nodes in a network are more accessible than others (accessibility refers to the distance of a station to all other stations). In a well-organized city, jobs tend to cluster around the more accessible nodes within networks. These highly accessible nodes are usually clustered in the dense and interconnected core of the transit network.

Efficient subway layouts in global cities (including the systems in, Shanghai, Tokyo, Seoul, London, Paris, and New York) converge toward a similar layout, characterized by a core-and-branches structure (figure 2.1), despite their geographical and economic differences (Roth and others 2012). Densely interconnected by crisscrossing lines, the core provides maximum accessibility to jobs and people. It usually extends only about 5 kilometers, because it would be costly to maintain a high density of stations beyond this radius. Outside this area stations tend to be located on branches, and the density of stations decreases sharply when moving away from the city core (see appendix A).¹

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**FIGURE 2.1 Core-and-Branches Structure of Subway Network**

Source: Roth and others 2012. Copyright: © 2011 Roth and others⁴.

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The core-and-branches layout and the differences in centralities in subway networks have a strong impact on local development potential. Major subway extensions with radiating branches, such as the one built in Seoul in the 1990s, made the central stations within the core more accessible from all other stations, creating strong market potential at the center. As a result, land prices rose, and development opportunities increased. Major subcenters may develop when subway extensions lead to large increases in accessibility, as they did in Gangnam-ku in Seoul, where, over a period of 20 years, a booming real estate market raised the property value in an area of 40 square kilometers above that of Busan, the second-largest Korean city and one of the first global container ports.\(^2\)

**Centrality in transit networks**

Centrality is a structural characteristic of stations (nodes) in the network that quantifies how a station fits within the transit network overall. Stations with high centrality scores are more likely to be key conduits of people and to help concentrate jobs and economic activities. Low-centrality stations can be termed peripheral. Lower centrality is associated with lower growth potential and fewer job opportunities. Three of the most commonly used measures are *degree*, *closeness*, and *betweenness* centrality.\(^3\)

**Degree centrality**

Degree centrality is the number of links per node. It is an important property of many networks, in particular the Internet (figure 2.2).

A map of London’s subway shows the dominance of King’s Cross as the most connected London node (map 2.1).\(^4\) The highest degree centralities—and thus

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**FIGURE 2.2 Degree Centrality of Financial Trading Networks**

- **a. High centralization (one node trades with many others)**
- **b. Low centralization (trades are more evenly distributed)**

Source: © Lada Adamic. Used with the permission of Lada Adamic. Further permission required for reuse.
the highest growth potentials—are located around the Circle Line and along the Central Line, defining Central London. There is a higher density of high-degree stations in the western part of Central London, where one third of London’s jobs are concentrated.

Closeness centrality
Closeness centrality expresses the average distance, measured in number of links, from a station to every other station in the network. Stations who connect to most others through many intermediaries get closeness scores that are increasingly nearer to zero. One property of closeness centrality is that it tends to assign high scores to stations that are near the center of local clusters.

Closeness centrality is an important property of many networks, including social networks (figure 2.3) and the London subway (map 2.2). Closeness centrality in London’s subway network confirms that Central London is the most accessible part of the network.

Betweenness centrality
The betweenness centrality of a station is equal to the number of shortest paths from all stations to all others that pass through this station. A station with high betweenness centrality has a large influence on the transfer of passengers through the network, under the assumption that passenger transfer follows the shortest paths. This calculation identifies the stations that are necessary conduits for passengers that must traverse disparate parts of the network, such as suburban trains
FIGURE 2.3 Degree and Closeness Centrality of the Facebook Network

Source: © Lada Adamic. Used with the permission of Lada Adamic. Further permission required for reuse. Note: Degree centrality (the number of links) is denoted by size. Closeness centrality (the sum of the length of the shortest paths between the node and all other nodes) is denoted by color.

MAP 2.2 Closeness Centrality of Subway Stations in London

Source: © Urban Morphology and Complex Systems Institute. Used with the permission of UMCSII. Further permission required for reuse.
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and subway lines or core-and-branches in a subway network. An example is the interchange stations along the Yamanote Line in Tokyo, which have high levels of betweenness centrality. Stations with high levels of betweenness centrality often do not have the shortest average path to every other station, but they have the largest number of shortest paths that have to go through them.

Betweenness centrality is an important property of many networks. The concept finds wide application, including in computer and social networks, biology, transport, and scientific cooperation. In the Facebook network (figure 2.4), individuals who act as bridges between clusters in the network have high betweenness centrality.

Map 2.3 highlights the betweenness centrality of the Circle Line, built in 1884. Most of London’s original train stations are located on the Circle Line, which connects the radiating branches of suburban trains with the Central London transit network.

Like the Circle Line, the Yamanote Line in Tokyo (built in 1885) is shaping growth, through a high level of centrality for its stations (box 2.1).

Calculating node value

The following key metrics are used to estimate node value. An index of node value is built by weighting these metrics (see appendix B).
Shaping Growth through Centrality in Tokyo

The first part of what would eventually become the Tokyo circular line, the Yamanote Line, started operating in 1885, the same year the London subway was inaugurated. The loop was completed in 1925. It has structured the city’s development, connectivity, and densification since the beginning of the 20th century. As both the Yamanote loop and the streetcar network within the loop were government owned, the government did not want competition from private railway operators, applying the same logic as in London. Tokyo’s metropolitan government prevented outside trains from entering Tokyo. Private railway operators had to establish their terminals along this circular line (they became high peaks of betweenness centrality), forcing millions of commuters to switch trains there.

The network today consists of several radial lines running from the suburbs to the center of Tokyo (box map 2.1.1). With the exception of the Chuo Line, all these lines terminate on the Yamanote Line, a circular line that connects most of Tokyo’s urban centers. This structure created natural growth points at the intersections of the main radials and the loop (Sorenson 2001; Chorus and Bertolini 2011), which became the seeds of urban subcenters.

The integrated development of railways and their surroundings was stimulated by the fact that private railway developers owned not only the railway infrastructure but also large parts of the areas surrounding it. Today, Tokyo’s subcenters with the highest peaks of value creation and the...
highest densities of jobs and GDP concentrated along the Yamanote Line. Box map 2.1.2 illustrates the intensity of activity by showing the density of tweets across the metropolitan area (with a gradient in intensity from blue to red with red representing the highest levels of density). This urban form was created by a century of policies integrating transport and land use.

Today the Yamanote Line is the most connected line in Tokyo. It spans approximately 12 kilometers North-South and 6 kilometers East-West, unofficially defining Central Tokyo, which is about the size of Manhattan. Only 2 of 29 stations do not offer connections with other subway or train lines. The other stations are mostly major hubs connecting to the high-speed train. Every day an average 3.55 million passengers circulate on the line, some 1.3 billion passengers a year. Box figure 2.1.1 shows the hierarchy of connectivity along the Yamanote Line in 2015 (transfers to Shinkansen stations were included to take into account the connectivity of the stations to the rest of Japan).

Public investment has leveraged huge amounts of private investment, while land value capture has allowed the financing of transit investments. The success of the Japanese programs of land value...
BOX 2.1  Shaping Growth through Centrality in Tokyo (continued)

capture is based on adding lines that increase the interconnectivity of the network. Most of the 48 urban rail and subway companies in Tokyo are private and derive a large part (up to a third) of their revenue from their activities as developers and property managers. They are highly sensitive to the real estate potential of new lines developments. When they build additional lines, they look systematically at increasing the number of interchange stations in order to reap the market benefits of the increase in node values by developing the land around the new hubs.

BOX FIGURE 2.1.1 Stations along Tokyo’s Yamanote Line, Ranked by Degree Centrality

Source: © Urban Morphology and Complex Systems Institute. Used with the permission of UMCSI. Further permission required for reuse.

Note: Figure shows inverse power law characteristic of a complex system. The exponent of the power law is higher than in London, because of the higher complexity and integration of Tokyo’s subway.

- **Degree centrality** describes the number of links in a node. For example, King’s Cross in London connects 6 subway lines and has 12 links. The Shanghai subway network will have 95 transfer stations, including 16 with 3 lines or more.
- **Closeness centrality** ranks the nodes based on their distance to all other nodes in the network.
- **Betweenness centrality** ranks the nodes based on the number of shortest paths between all other nodes that pass through a given node.
- **Intensity of node activity** captures the strength of traffic flows in a node. It can be described by the frequency of departures of public transportation and/or by the daily ridership of a node, a comprehensive measure of node activity. The
ridership of Shinjuku Station, in Tokyo, is 3.5 million passengers a day, the highest in the world.

- **Intermodal diversity** refers to the number and variety of transportation modes a station connects. The more options and variety of choices a station offers, including connection to subways, buses, and high-speed rail, the higher its connectivity. Providing a variety of modes and integrating bicycles and bus facilities, as in Malmö, Sweden, is key for increasing transit connectivity and enhancing accessibility to jobs, as shown in the Zhengzhou case study (chapter 8).

**Drivers of Place Value: Local Connectivity, Fine-Grain Urban Fabric, and Mixed Use**

Because place value varies widely, the types of planning, urban design, public policies, and investment strategies will be different based on local station area context. Place value for residents is derived from vibrant, sustainable communities that provide easy access to jobs, shopping, and services on foot or bicycle. Such communities provide a range of benefits, including reduced transportation costs, improved access to various amenities (including high-quality education), and improved public health.

A key driver of place value is the quality of the urban fabric, which is based on human scale, permeability, diversity, and the capacity to evolve. High quality is achieved by small blocks, subdivided into land lots of various sizes, and a high density of street intersections.

The block is a central element of urban planning and urban design. It is the smallest area that is surrounded by streets. City blocks are the space for buildings within the street pattern of a city; they form the basic unit of a city’s urban fabric. City blocks can be subdivided into smaller land lots, usually privately owned. City blocks are usually built up to varying degrees and thus form the physical containers of public space. The Portland Transit-Oriented Strategic Plan demonstrates a correlation between block size and land value, with smaller blocks having higher land values (CTOD 2011).

Place value is unevenly distributed across an urban area. Places across cities have a wide range of intensities and a mix of land uses. In a typical city, many stations areas are mainly residential, with low intensity, while a few are more job oriented and mixed use, with high intensity.

Walkability also varies. It depends on the street patterns and the design of streets as places for people. Street patterns determine not only whether residents and workers can access rail and bus transit but also whether they can access the shopping, jobs, and services located in their immediate neighborhood. Street patterns with blocks about 100 meters per side and high connectivity enhance local accessibility (see box 2.2). In contrast, superblocks and gating decrease accessibility.

An index of place value can be built using a weighted sum of the following metrics (see appendix B):

- **Density of street intersections** measures the density of street intersections within an 800-meter radius of each station. Connected street patterns with a
**Box 2.2 Small Block Size and Livability in Manhattan**

Urban blocks in Manhattan are 60 x 190–280 meters, about the same size as in the historical center of Paris (box photo 2.2.1). In the North-South direction, the average distance between intersections is similar to that of European Medieval cities; in the East-West direction, the average distance is slightly greater than in most European 19th century cities. The size of Manhattan’s blocks make the city highly walkable. The block composition is highly diversified, including public spaces such as Rockefeller Center (box photo 2.2.2).

As a result of its small blocks, dense street pattern and dense subway network, 100 percent of the workforce in Manhattan is within easy reach of a transit station by walking.

**Box Photo 2.2.1 Grid of Manhattan Showing Small Block Size**

Source: Salat with Labbé and Nowacki 2011. © Serge Salat. Used with the permission of Serge Salat. Further permission required for reuse.

**Box Photo 2.2.2 Rockefeller Center, a Public Space in Manhattan**

Source: © Françoise Labbé. Used with the permission of Françoise Labbé. Further permission required for reuse.

High density of intersections promote accessibility and walkability. International best practice shows that an intersection density of about 100 intersections per square kilometer enhances accessibility.

- **Pedestrian accessibility** measures the proportion of the area within 800 meters of a station that is within a 10-minute walk. Block sizes of about 100 meters per side with vibrant edges (facades with businesses on the perimeter) promote more compact development and walkability.

- **Diversity of land uses** measures the different types of land use with an 800-meter radius of a station. Areas with commercial urban amenities such as restau-
rants, grocery stores, and specialty retail shops allow residents to perform daily activities.

- **Density of social infrastructure (amenities)** measures the number of cultural, educational, and health services as well as the social infrastructure, within 800 meters of a station. When concentrated in a compact area or easily accessible, such amenities increase place value.

- **Pedestrian/bicycle connectivity** measures access to sidewalks and bikeways, which encourage people to walk or cycle to transit stations and neighborhood destinations. It can be added to the other measures where appropriate.

### Drivers of Market Potential Value: The Interaction of Supply and Demand

The market potential value of a station area is assessed by understanding the unrealized market value around it. Market demand at the city level also needs to be understood, to put such analysis in context. The availability of relevant data varies widely from city to city; the approach needs to be tailored accordingly, focusing on local drivers of demand and supply.

#### Drivers of demand

Market potential depends on overall demand for real estate development at the city level and on the economic activity and attractiveness of the specific place for developers and businesses. For businesses and commercial activities, local job densities and high accessibility to other job concentrations across the urban area and expected growth are crucial, because they determine the agglomeration economies of locating around a specific station. For residential development, market potential depends greatly on the number of jobs accessible in 30–45 minutes from a location.

#### Drivers of supply

Market potential depends on available land opportunities, the ease with which land can be redeveloped, and the volume of construction permitted. When a location is highly attractive, the market develops high-density programs with mixed-use programs, as long as FARs are adjusted upward, as is in King’s Cross in London (26 hectares) and Hudson Yards in Manhattan (22 hectares).

Emerging areas that have some market potential but few mixed-use buildings may be good candidates for TOD investment. TOD policy can help push a ripening market and escalate development intensity and quality. In areas with less market potential, strong incentives are needed to encourage market development and the desired mix of land uses and building types.

#### Market activity

Market activity is an important component of market potential value. It derives from the intensity of market transactions during a sufficiently long period for residential and mixed-use (residential/commercial) land uses. Box 2.3 illustrates the role of an increase in connectivity and high-quality public space in building strong market demand in Canary Wharf, in London.
**BOX 2.3 Exploiting High Market Potential Value at London’s Canary Wharf**

Canary Wharf is the highest peak of job and office space density in London, with about 105,000 jobs on 28.8 hectares. Development of Canary Wharf owes much to the extension of the Jubilee Line, which began in 1993. The increase in the value of Canary Wharf rose by an estimated £3.9 billion between 1992 and 2002, of which up to £1.9 billion can be attributed to the extension, according to the real estate firm JLL. High-quality landscaping and architecture supported the transformation (box photos 2.3.1 and 2.3.2).

**BOX PHOTO 2.3.1 Water Landscaping at London’s Canary Wharf**

Source: © Françoise Labbé. Used with the permission of Françoise Labbé. Further permission required for reuse.

**BOX PHOTO 2.3.2 Canary Wharf Subway Station**

Source: © Françoise Labbé. Used with the permission of Françoise Labbé. Further permission required for reuse.
Calculating market potential value
Market potential value metrics provide a rough measure of the feasibility of TOD development based on local conditions (see appendix B). It depends on overall demand for additional real estate at the city level. Market potential can be measured with a weighted combination of demand-side and supply-side measures.

Demand-side measures include the following:

- **Human density** measures the number of people and jobs per square kilometer within a catchment area of 800 meters around a transit station. The number of residents and workers in an area and the balance between jobs and working-age population is correlated with the attractiveness of an area for residents and businesses and with the development of a strong real estate market.

- **Activity mix** measures the mix of residents and jobs in an area. It can be measured through the job to resident ratio.

- **Forecasted rate of growth in human density** indicates the expected evolution around a station. It is typically forecast as part of urban mobility plans or mass transit development plans.

- **Number of accessible jobs** measures the number of jobs accessible through transit and walking within a given time (usually 30–45 minutes). It measures an area’s attractiveness for residents and companies, which want strong linkages with other dense nodes of jobs within the urban region.

Supply-side measures include the following:

- **Real estate opportunities** measures the potential for developable floor space located within 400 meters of a station for the highest premium and 400–800 meters for a lower premium. Real estate opportunities are based on additional square meters of floor space that can be built on land adjacent to the station—the difference between the maximum floor space that can be built within the regulatory FAR and the existing built floor space. High FARs support a high density of people and jobs and a high volume of construction.

- **Volume of transactions** provides useful indications of the state of the market. A decades’ worth of data should be examined (where available), to provide a longer-range look at performance. Overall demand for additional real estate at the city level should be considered.

Impact of Station Locations on Values
International experience suggests that node value (high connectivity and accessibility within the network) plays a major role in dense core areas, where it fosters economic and jobs concentration and commercial real estate development. Canary Wharf and King’s Cross in London are examples of projects where increased connectivity caused spikes in market value.

Connectivity plays a less important role than place value in low- to medium-density areas. One of the key features of residential property value is the residential self-selection process (a process in which individuals select places that fit their preferences, in particular for amenities and schools). Self-selection explains large varia-
transformations between value changes (and direction) at different stations on a given line (Higgins 2015), even though all benefit from increased accessibility. Stations where place value is more important than node value are typically in the long tail of single-line stations, for which node value is generally weak (the strongest node values are major hubs, which are usually within the core part of subway systems).  

**Types of Station Areas**

The three values are unevenly distributed across station areas. Some stations are important interchanges between different subway lines and different transport modes. These stations offer high potential for new developments. Other stations offer less potential, because they are in suburban areas, with less vibrant real estate markets and fewer connections to the rest of the network. These stations offer different opportunities, such as cheap available land to redevelop, as the analysis of risks and opportunities in fringe and central locations along the Crossrail route in London demonstrates (chapter 7). Different types of stations require different types of development strategies, investments, and policy instruments. A methodology is needed to cluster stations based on their node, place, and market potential values.

**Clustering Station Areas Based on Node Value**

Node value is higher at subway network cores than at the periphery. At network cores, stations are interconnected in dense clusters around major hubs. At the periphery of the network, stations are spaced much farther apart. The mathematical regularities in the core-and-branches layout of many subway networks, the distribution of transit centralities, and the intensity of flows across many subway systems allows a clustering of node value into single-line stations, core transfer stations, and highly connective hubs

1. Single-line stations belong mostly to the branches of the urban rail system extending outward into the suburbs.
2. Core transfer stations are transfer stations with two or more lines concentrated at the city core.
3. Highly connective hubs rank high in intermodality, centrality, and intensity of passengers flows. They have the highest node values.

**Clustering Station Areas Based on Place Value**

Station areas can be grouped into three types based on their place value: suburban, urban, and intense urban.

1. Suburban areas are generally nontransit areas or areas close to transit that do not possess the urban character that would best support TOD. This category generally describes low to moderately populated areas that lack a combination of street connectivity, pedestrian and bicycle facilities, and urban amenities to more fully support the level of transit service. Suburban areas are generally
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mono-functional (either residential or industrial or business parks, with no mixed use) on large areas of land.

2. Urban areas are moderately or substantially populated areas with a good or improving pedestrian/bicycle network and some mix of neighborhood retail and service amenities as well as a moderate mix of supporting jobs.

3. Intense urban areas combine a high diversity and intensity of uses with high economic concentrations, making these areas the most likely to support a transit lifestyle.

**Clustering Station Areas Based on Market Potential Value**

Station areas can be clustered into three types based on their market potential value: limited, emerging, and strong.

1. Limited areas have weaker market conditions and lack the demand necessary to support new compact and/or mixed-use development. TOD investments in these areas are less likely to catalyze additional private development and should be used only on a limited basis. An emphasis on visioning and planning, to begin to develop interest, is more appropriate.

2. Emerging areas have limited to moderate real estate market conditions; intensive building types are generally not supported in the near term. Although they may lack immediate market support for TOD, emerging areas may be ideally suited for catalytic TOD investments to enhance local market strength, because land and development costs are not high and small investments may catalyze further market investment.

3. Strong areas have market conditions that are already ripe or ripening, TOD investments should focus on improving urban living amenities and developing prototype developments.

This approach is not predictive of the financial feasibility of a new development in a category. Rather, it provides a sense of how a station area is likely to perform.

**Policies for Different Types of Stations: Infill, Intensification, and Transformation**

The 3V Framework is a virtuous circle. Higher place, node, and market potential values induce higher economic value, which in return raises place and node value, as more and more opportunities emerge and investments become more profitable. The 3V Framework integrates the different aspects and scales of urban development.

TOD investments are intended to stimulate a market response, but many other critical investments and incentives are needed. TOD investments should take a comprehensive view of programs and policies that can help realize the full range of TOD benefits. These comprehensive strategies include investments in human capital, neighborhood services, and business development, which may improve
an area’s long-term prospects for TOD. Scaling up TOD at the metropolitan region level requires changes in a range of geographic and economic contexts, not just in core urbanized areas. Many suburban stations have limited near-term market development potential but substantial land opportunities. Station area planning and implementation efforts are needed in these areas. Many suburban stations in Chinese cities, for example, have low densities and significant developable land, which can accommodate urban growth.

Overlaying node, place, and market potential values creates nine area types, each of which calls for different public policies and timing of investments (figure 2.5). This classification is the first step in an investment strategy at the city scale. Many of the types face similar challenges and would benefit from similar investments strategies.

Depending on their TOD and market potential, three types of implementation strategies can be defined:

- **Infill** is mainly for nodes in suburban neighborhoods with single transit lines and low market value. It involves the reuse of urban land for new, higher-density construction. The strategy is to promote long-term planning and increase activ-
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Infill levels and transit service through increased densities; plan and fund multi-modal transportation system; and plan for maintaining equity in vulnerable or challenged communities. Such locations can provide good opportunities for affordable housing.

- **Intensification** is for emerging station areas in urban neighborhoods with interchanges and emerging markets. Intensification areas are typically built-up areas with good existing or potential public transit links that can support redevelopment at higher than existing densities. The strategy is to invest in catalytic TOD projects to prime and push the market, promote development-oriented planning, and evaluate and address missing multimodal connections and accessibility. Such locations can be prime opportunities to provide affordable housing.

- **Transformation** is the strategy to apply in major hubs. Creating a high level of place value—through job concentration and good urban design, including major investments in public spaces—can create high peaks of land and real estate value. The strategy is to invest in aggressive TOD projects to push the market, through significantly higher densities and lower parking ratios; innovative building types and advancements in urban design; employment opportunities; some affordable or workforce housing; and increased transit service, capacity, and amenities to support intensity of uses.

The nine types of development in each matrix are grouped into three clusters. The types on the diagonal are balanced types, needing infill, intensification, or transformation depending on their value. The most promising types are the ones outside the diagonal, which can be considered as unbalanced. They offer great potential for transformation, such as the massive redevelopments at King’s Cross and Hudson Yards. These matrices are not to be considered as static descriptions but as dynamic tools for identifying the levels of possible transformations of different TOD areas.

The actionable strategies depend on the relative strengths of values at each location. A location with a high node value (a highly connective major hub) such as King’s Cross, for example, can acquire a high market potential value through massive investments in high-quality public space when the market timing is right. Such a strategy is transformative. At the other end of the range, in suburban stations on a single line with a limited market potential value, infill development would be favored.

**Key Strategies for Increasing Values**

Planners can adopt the following approaches for increasing values.

**Increasing Node Value**

Network structures vary. Some have more hubs than others and interconnect more neighboring stations with criss-crossing lines. These network organizations shape land uses and land values differently. Networks that present strong concentrations of lines in focal points, which interconnect many lines and transportation modes, shape economic concentrations in spikes, with high peaks of value concentration. In con-
Transforming the Urban Space

...networks that are flat, with no major hubs and no dense concentration of lines in a core, do not offer strong opportunities for capturing high land values around stations. As efficient urban spatial organizations require concentrating production factors to create agglomeration economies, the more hierarchy a network presents, the better it is for shaping land uses in a productive way for economic growth.

In London, Tokyo, and Seoul, transit network structures determine how concentrated population, jobs, and economic densities will be. The spatial development strategy of cities like these is to first create a hierarchy of hubs in the transit network and then to encourage public and private investment to create high place value around these nodes. Subway systems in China, developed much more recently, are less hierarchical so far than subways that evolved under market forces and over long periods of time, like the London or Tokyo subways.

Key strategies for increasing node value include interlinking neighboring stations into clusters and increasing accessibility of core stations within the network. Interlinking—that is, increasing the density of links between neighboring stations—creates many triangles between neighboring stations and tightly connects the network, offering passengers varied possibilities for interchange. Increased accessibility of stations within the network makes a given station more valuable. Successful subway extensions, such as the addition of four lines in Seoul, cluster a large number of highly accessible stations in the network core, concentrating density and economic activity. Such a network level approach needs to be supported by increased service levels and service integration.

**Increasing Place Value**

TOD creates place value through greater compactness, mixed-use development, and an urban environment that supports vibrant and active communities. The optimal mix of economic, educational, transport, and recreational opportunities ultimately gives rise to a people-centered city, where the needs of all people are placed at the core of all planning processes. TOD creates new street-life patterns where people can move about easily and confidently, linger, and get together with other people.

The City Prosperity Initiative (UN-Habitat and International City Leaders 2015) provides a comprehensive assessment of cities’ prosperity based on indicators along six dimensions: productivity, infrastructure, quality of life, equity and social inclusion, environmental sustainability, governance, and legislation. According to this index, 85 percent of cities with a very solid prosperity index are in Europe, led by Oslo, Copenhagen, Stockholm, Helsinki, Paris, and Vienna (Amsterdam, Tokyo, London, and Zurich are also in the top 20). These cities offer high-quality public spaces and dense street patterns. Box 2.4 summarizes key benchmarks for enhancing place value derived from international best practice and UN-Habitat recommendations.

Key strategies for raising place value are increasing compactness and increasing the diversity of land uses. As identified early by Jane Jacobs (1961), the compact city (or city of short distances) is an urban planning and urban design concept that promotes relatively high residential density with mixed land uses.

At the scale of the city, being compact means being integrated spatially by public transit systems. Compactness can be applied to a neighborhood scale, re-
resulting in spatial integration by good walking and cycling connectivity and orientation toward transit stations. A large resident population provides opportunities for social interaction as well as a feeling of safety. A compact city is also a more sustainable urban settlement type than urban sprawl, because it is less dependent on cars and requires less infrastructure provision per capita. The two performance objectives for compactness focus on the proximity of a development to existing urban activity and short travel time to major trip generators in the central and regional destinations (ITDP 2014).

Providing diverse and complementary uses within the same or adjacent blocks reduces trip lengths and support the clustering of economic activity (photo 2.1). Mixed-use development helps create high-quality neighborhoods with vibrant and sustainable communities amenable to a concentration of commercial, cultural, and educational amenities.
In high-value places, personal motor vehicles become largely unnecessary in day-to-day life, making it possible to reduce the roadway area. Scarce and valuable urban space resources can be reclaimed from unnecessary roads and parking space and reallocated to more socially and economically productive uses (ITDP 2014). Despite wealthy populations, Paris intra-muros and Manhattan have extremely low rates of car ownership, because people find cars unnecessary, expensive, and inconvenient. Half of Paris intra-muros households and less than half of households in New York own a car. Within the five boroughs, ownership is lowest in Manhattan (23 percent of households), followed by Brooklyn (44 percent) and the Bronx (46 percent). In contrast, a large majority of households in Queens (64 percent) and Staten Island (84 percent) own at least one car. These overall ownership rates are far lower than in the rest of the United States, where 92 percent of all households own at least one car and 20 percent own three or more vehicles.

To support compactness and mixed use, neighborhoods need to be designed in a way that promotes walking and cycling, reclaiming the streetscape from cars. Walking and cycling are the most natural, affordable, healthy, and clean modes of travel for short distances—and a necessary component of the vast majority of transit trips.

The size of urban blocks and the street network influence walkability and bikeability. Small block sizes reduce vehicle miles traveled and raise property values (CTOD 2011). Dense networks of streets and paths and small blocks enhance walkability. Certain thresholds differentiate pedestrian cities, TOD cities, and car-dependent cities. Japanese cities with an average distance between intersections of 50 meters (even in modern Tokyo) are highly pedestrian friendly (Salat 2011). European cities built in the 19th century as well as the historical core of U.S. and some Asian cities have average distances between intersections of 100–150 meters, the TOD planning sizing.
Figure 2.6 and photo 2.2 show a simple street network model. In an area of 1 square kilometer, 10 vertical and 10 horizontal streets are designed to form a street grid. The distance from centerline to centerline between two adjacent streets is 111

**FIGURE 2.6 Street Network Model Design**

Source: Adapted from UN-Habitat 2014.
Note: Purple lines indicate arterials. Green lines indicate feeder streets

**PHOTO 2.2 Barcelona Urban Street Grid on an 800-Meter Side Square**

meters. Taking into account that each street on the perimeter of the diagram is counted as half (because it belongs to two squares of 1 square kilometer each), the total street length is 18 kilometers and the number of intersections per square kilometers is 81. In this street network model, recommended by UN-Habitat, both street hierarchy and block size are considered. This simple model illustrates a good balance between street and other land uses. Other patterns, like the rectangular pattern in New York, are also effective. Cities have much to gain in terms of quality of the urban space in developing a street density level similar to the one recommended in the model.

The creation of a vibrant and active pedestrian public realm plays a major role in stimulating walking. Walking can be highly attractive when sidewalks are animated and lined with useful ground-floor activities and services, such as storefronts and restaurants. Pedestrians and cyclists increase the exposure and vitality of local retail shops.

Cities are rediscovering the value of developing cycling networks; early adopters have realized that cycle-friendliness enhances place value. It is strongly promoted in Amsterdam, Paris, and Malmö (photo 2.3). Key factors encouraging cycling are safe street conditions, in particular at intersections, and secure cycle parking and storage. A safe cycling network connecting all buildings and destinations through the shortest routes available is a basic TOD requirement (ITDP 2014). Cycling can be an attractive travel option only to the extent that bicycles can be securely locked.

PHOTO 2.3 Bicycle Parking in Malmö, Sweden

Source: © Françoise Labbé. Used with the permission of Françoise Labbé. Further permission required for reuse.
Increasing Market Potential Value

Increasing residential density

Market potential is increased on the demand side by encouraging higher residential and employment densities and higher employment rates. It is increased on the supply side by greater diversity of land parcel sizes, which create a vibrant land market, and higher FARs near transit stations.

Residential densities are not uniformly distributed (figure 2.7). High residential density around stations results in well-populated streets, ensuring that urban places are lively, active, vibrant, and (often) safe places where people want to live. Density delivers the customer base that supports a wide range of services and amenities and makes local commerce thrive. As many of the most famous and desirable neighborhoods in the world attest, high-density living can be highly attractive if supported by the right level of infrastructure (photo 2.4). Cities can stimulate increased density around stations by adjusting their land-use plans.

High residential density does not imply vertical urban forms. With 21,000 inhabitants per square kilometer (25,000 excluding the Bois de Boulogne and Bois de Vincennes), seven-story-high intra-muros Paris, where strict regulations ban high-rises, achieves the same average residential density as Manhattan. Indeed, several districts have densities of 40,000 inhabitants per square kilometer—much higher than in vertical urban forms. Vertical growth is most often low density, because of inefficient land use (much urban land is left empty or occupied by oversized road infrastructures). Cities benefit from growing in a more compact form, with traditional low- and medium-rise buildings in small-perimeter blocks.

Increasing job density

Job density feeds economic productivity as a result of economies of agglomeration. A doubling of employment density in U.S. cities corresponds to a 6 percent increase in hourly labor productivity (Haughwout 2009). A study of 261 Chinese
cities shows that economic productivity in China increases by 8.8 percent with a
doubling of employment density (Fan 2007). Economies of agglomeration are the
benefits firms obtain by locating near one another. This concept relates to the idea
of economies of scale and network effects. As more firms in related fields of busi-
ness cluster, their costs of production may decline significantly. Even when com-
peting firms in the same sector cluster, there may be advantages, because the
cluster attracts more suppliers and customers than a single firm could achieve.
Cities form and grow to exploit economies of agglomeration.

Job density increases market potential values as economic density determines
firms’ locational choices. Across the United States, job density explains half of the
variation in economic productivity per capita. Job and business densities are key
to reaping the benefits of agglomeration economies, increasing economic pro-
ductivity, and fostering innovation. Concentrating economic activity in particular
locations enables firms to reap economies of scale and scope and bring talented
people together to share ideas and innovate. Job densities reflect such phenom-
ena by exhibiting high peaks of concentration (figure 2.8).

**Increasing human density**

Human density is the total number of residents and jobs in a district. It gives an indication
of the intensity of development. The number of residents and workers in an area
and the balance between jobs and the working-age population has a direct corre-
lation with the attractiveness of an area for residents and businesses and thus the de-
velopment of a strong real estate market. Cities can create the conditions to allow
such increases in human density to take place by setting a vision, building consensus,
planning actions, and investing in infrastructure that supports such increases.
Increasing the diversity of land parcel sizes to create a vibrant land market

Diversifying the size of land parcels can help create an adaptive city that can meet future demand. Manhattan provides a good example of such an approach. Originally, its land parcels were sold in units of 200 square meters (about 300,000 units of land for sale on an area the size of Manhattan [about 60 square kilometers]). Such small parcels fostered an active land market with great potential of future mixed use. Over time plots of land in Manhattan have been consolidated, but 40 percent of all land still remains the initial size set two centuries ago. Very few parcels occupy whole urban blocks (figure 2.9).

Plots in urban China are much larger: current urban development is based on 400 meter x 400 meter superblocks. On an area the size of Manhattan, there would be only 250 units of land for sale in a Chinese new town. Cities can increase the vibrancy of their land market by creating a wider range of block sizes and encouraging diversity of development.
Increasing floor area ratios near transit stations

In TOD projects, local authorities often reset FARs at higher values, to allow for densification and to generate revenue streams that can be captured to finance infrastructures (transit and public spaces). Commercial FARs can be raised near stations; residential FARs can also be reset, albeit at lower values than commercial FARs.

Such approach has an impact on both land value and compactness. A 2015 analysis of the options for Shanghai found that existing areas around metro stations would be sufficient to accommodate the required built area for the estimated growth in population by 2050 if FARs are raised to levels in Hong Kong SAR, China; New York; Seoul, Singapore; and Tokyo; (World Bank and Chreod Ltd. 2015).

Notes

1 In statistics a long tail in a distribution is the portion of the distribution having a large number of occurrences far from the “head” or central part of the distribution. In inverse power laws, the long tail is the high frequency of occurrences of small values (in metro systems the large number of stations with only one line passing through them). The term long tail has gained popularity in recent times for describing the retailing strategy of selling small numbers of a large number of unique items, usually in addition to selling a small number of popular items in large quantities.

2 This section draws on some of the terminology and definitions used in CTOD (2011).

3 Urban catalysts (used, for example, in New York) are new redevelopment strategies comprising a series of projects that drive and guide urban development. In the past, redevelopment efforts such as urban renewal and large-scale redevelopment projects often jeopardized the vitality of downtowns. The difference between an urban catalyst and these redevelopment strategies is that catalytic redevelopment is a holistic, not a clean-slate, approach to revitalizing the urban fabric.

4 This section draws on UN-Habitat’s work on sustainable planning and city prosperity and on the TOD standard of the Institute for Transportation and Development Policy (ITDP 2014).

5 New economic geography provides an integrated and micro-founded approach to spatial economics. It emphasizes the role of clustering forces in generating an uneven distribution of economic activity and income across space. The approach has been applied to the economics of cities, the emergence of regional disparities, and the origins of international inequalities (Bogart 1998; Brueckner 2005; Coe, Kelly, and Yeung 2007; Strange 2008; Venables 2008; Moretti 2013).

References


Urban transit systems and urban regeneration are essential for promoting urban economic growth and improving the quality of life by providing access to places and activities for work, education, services, and leisure. To establish affordable, high-quality transport systems, cities must ensure that their transport systems are financially sustainable. Revenue from users, indirect beneficiaries, and public sources must be sufficient to pay for new investments in infrastructure and fund maintenance and operation of existing facilities and services.

Many cities in developing countries face underfunding for urban transport. In these cities, the upfront investments needed for new transport infrastructure are large compared with their fiscal capacity, and revenue from their still small-scale and often poor-quality systems and other sources is insufficient to cover maintenance and operation expenses, let alone new investments.

By choosing the most appropriate sets of financing instruments and focusing on wise investments, cities can design comprehensive financing for all types of urban transport projects, using innovative, multilevel revenue sources that promote efficient pricing schemes; increase overall revenue; strengthen sustainable transport; and cover capital investments, operation, and maintenance for all parts of a public transit system. (For a framework for achieving comprehensive and sustainable urban transport financing, see Ardila-Gomez and Ortegon-Sanchez 2016.)

Suzuki and others (2015) describe how cities can use land value capture to finance and encourage more inclusive urban growth. By investing some of the captured value in parks, sidewalks, street lights, and cycle lanes, city governments can work with transit agencies, developers, and communities to develop efficient, attractive, and safe public places, increasing property values. By offering bonus floor area ratios (FARs) and other regulatory incentives, they can require developers to...
provide affordable housing and daycare centers in their new facilities (chapters 5–7 describe how New York and London have used these mechanisms.)

This chapter introduces value capture in the context of the 3V Framework by describing how the dynamic interplay of values (particularly node and place value) creates economic value and facilitates value capture that can be used to finance investments in urban growth and transit. Transit-oriented development (TOD) is the key to turning node-place dynamics into market success stories such as King’s Cross in London and Hudson Yards in New York, described in chapters 5 and 6. Addressing imbalances between values can unleash development potential.

**The Dynamic Power of Imbalances between Values**

The 3V Framework allows policy makers to assess development potential in a proactive and dynamic way. Not only are the values of stations unevenly distributed; the different types of values for each station may differ greatly. The most promising areas of development are the ones where increased connectivity through public investment comes in places where there is room for further development.

Bertolini’s (1999) node-place model considers place and node values. It includes an analysis of the dynamic interplay of place and node values to create market potential and economic value. According to Bertolini, by increasing accessibility, improving the transport provision (node value) of a location will create conditions favorable to the further development of the location. In turn, the development of a location (an increase in its place value) will create conditions favorable to the further development of the transport system, initiating a positive feedback loop of development. This model highlights the dynamic potential of imbalances of values within the same station area (box 3.1).

Unbalanced nodes and unbalanced places create strong development opportunities, because they are underutilized assets. When leveraging these development opportunities, specific policies should be put in place to ensure equity, such as professional training for local populations or inclusionary housing.

King’s Cross was an unbalanced node, with one of Europe’s highest levels of accessibility, connectivity, and centrality for high-speed rail, national and regional rail, urban rail, and subway networks (photo 3.1). The area had a strong imbalance, with underutilization of its 27 hectares of land. Creating place value with a high-quality public realm (40 percent of the land); 20 new connective streets; 10 plazas and gardens; and a mixed-use program that includes Google’s second global headquarters, digital start-ups, inclusionary housing, a school for the arts, cafes, and retail stores increased place value, which in turn increased market potential.

Hudson Yards (image 3.1) is a major high-density, mixed-use land redevelopment planned and designed to capture job growth in the knowledge and creative economy. It was an underutilized land asset close to the highest concentration of creative and financial industries in Midtown Manhattan. Massive investment in transit infrastructure (the Line 7 extension) and high-quality public space increased place and node value, fostering high market potential.
The Dynamic Interplay of Values and Its Contribution to Value Capture

The choice of case studies in this book underscores the potential of run-down, underutilized areas as drivers for creating market potential value when increasing connectivity (increasing node value) and putting in place sufficient investment in urban fabric regeneration through a high-quality public realm. King’s Cross is a former rail industrial site that was regenerated. Hudson Yards is being built above a rail yards. Malmö and Hammarby (in Sweden) regenerated suburban docklands. They demonstrate that high market potential can also be created in suburban areas if good linkage is established with the core city and the area is well planned and designed. Malmö and Hammarby underline the importance of the quality of urban design in creating value (chapter 4). Examples of urban redevelopment along Crossrail also demonstrate the potential of fringe locations (chapter 7).

**BOX 3.1 Interplay of Values in Bertolini’s Node-Place Model**

The node place model distinguishes five types of situations based on a station’s node and place value (box figure 3.1.1).

1. **Balance:** Both node and place are strong. Transportation infrastructure and local land use support each other, maximizing market value.
2. **Stress:** The intensity and diversity of infrastructure and land use come close to the maximum. Although station areas may be considered under stress and at maximum development, international experience shows that development in areas with peaks of connectivity and land use intensity tend to continue growing, as experienced in Shinjuku in Tokyo where real estate is still booming and new lines are added.
3. **Dependence:** There is no competition for free space, and demand for infrastructure is low. Both node and place values are relatively weak; factors other than node-place dynamics (for example, subsidies) must intervene for the area to sustain itself.
4. **Unbalanced node:** The supply of infrastructure is stronger than land use. There is potential of development in enhancing place value to leverage on the relative oversupply of connecting infrastructure. An example is King’s Cross (chapter 6).
5. **Unbalanced place:** The intensity of land use exceeds the supply of infrastructure. Local development potential should be encouraged by providing supportive infrastructure that increases connectivity. An example is Hudson Yards (chapter 5), where anticipated intense real estate development, encouraged by raising FARs, called for the extension of subway Line 7. Higher connectivity encourages existing economic activity and increases market value potential.

**Source:** Adapted from Bertolini 1999. © Luca Bertolini. Used with the permission of Luca Bertolini. Further permission required for reuse.
The Feedback Loop of Value Creation and Capture in Transit-Oriented Development

New transit infrastructure or planning decisions (such as rezoning at higher values or investing in the public realm) increase land value around transit stations. Capture of this value can create a positive feedback loop for financing infrastructure,
enhancing the public realm, and supporting inclusionary housing.\textsuperscript{2} The unlocking of an increase in the potential value of underused assets (land and/or structures) as a result of a public sector intervention (rezoning or provision of transit infrastructure) stimulates demand from the private sector. Subsequent investment and development from the private sector ensure that potential asset value increase is realized (Huxley 2009). Figure 3.1 illustrates this feedback loop.

Value capture finance can be defined as “the appropriation of value generated by public sector intervention and private sector investment in relation to an underused asset (land and/or structure) for local reinvestment to produce public good and potential private benefit” (Huxley 2009). It can take the form of monetary or in-kind contributions from the private to public actors. Local value recycling is the reinvestment of monetary or in-kind contributions from the private sector within the same development site or scheme. This reinvestment can pay for the initial public intervention but tends to fund further interventions.

Value capture finance increases the incentive for both public intervention and private investment by creating a win-win situation. It divides the cost of urban development between the public and private sectors, without the public sector necessarily undertaking a large share of the initial investment. Figure 3.1 captures the positive feedback loop of value capture.

FIGURE 3.1 Feedback Loop of Value Capture Finance

Source: Huxley 2009. © ULI. Used with the permission of ULI. Further permission required for reuse.
The 3V Framework identifies imbalances in local development and thus underutilized assets (either because an increase in connectivity linked to public investment in infrastructure calls for a redevelopment or because high place value calls for investment in connectivity to create a positive feedback loop for market growth). It allows public investment be fine-tuned to market response potential in order to initiate these positive value capture feedback loops.

The case studies presented in later chapters illustrate the positive feedback loops created in New York and London by the coordinated actions of public and private sector. The different strategies initiating these positive feedback loops are discussed below, following both the 3V Framework and the framework proposed by Huxley.

**Value Creation**

Value creation strategies involve increasing node, place, and market potential value, with each one supporting the others. They are illustrated with a short summary of the strategies used in King’s Cross and Hudson Yards, where potential asset values were created by public sector intervention that increased node and place value. Public investment in parks, mass transit, and infrastructure will help make these places the most livable areas of their cities.

In both projects, transport infrastructure supports higher node value. Major investments in local transport infrastructure (of £2.5 billion to date) turned King’s Cross/St Pancras into the most significant interchange for local, national, and international travel in London. At Hudson Yards, investment in infrastructure includes extension of the No. 7 subway west and south from its old terminus at Times Square. A new station is being built at W. 34th Street and 11th Avenue. The $2.4 billion Line 7 extension was funded with New York City funds from municipal tax increment financing (TIF) bond sales, which are expected to be repaid with property tax revenues from future developments in areas served by the extension (Fitzsimmons 2015).

Higher place value was supported through environmental and social improvements and investments to enhance the urban quality and image of both sites. Development of King’s Cross combined physical regeneration (developing sites, refurbishing buildings) with community regeneration (providing skills, training, community facilities). At Hudson Yards, the public sector renovated the Javits Center ($465 million). At both sites, much attention was given to high-quality public space and iconic architecture. Three major New York parks (the third section of the High Line, Hudson River Park, and Hudson Park & Boulevard) converge at Hudson Yards. They are supported by $630 million of public investment in public space and parks.

Higher market potential value was supported by allowing population increases and land use changes, using planning and regulatory tools. Both King’s Cross and Hudson Yards are creating very dense mixed-use communities, with human densities (or projected densities) of about 1,750 per hectare. Such transformation is fostered by rezoning at a higher FAR, with transparent mechanisms to purchase rights for additional FAR above the base FAR, and with margins of flexibility for adapting to market changes. This allows the public sector to capture part of this increase in value to finance needed investments (box 3.2).

Enhanced destination branding and marketing enable new areas to emerge. King’s Cross and Hudson Yards are being transformed from derelict industrial rail-
The Department of City Planning is proposing a rezoning of Greater East Midtown, a 78-block area surrounding Grand Central Terminal, where densities are already among the highest in New York City (box map 3.2.1). The purpose of the rezoning is to ensure the area’s future as a world-class business district and major job generator.

This proposal is a targeted plan involving multiple agencies. New commercial buildings on qualifying sites can exceed the base FAR in exchange for improvements to the area’s public realm or transfer of unused floor area from the area’s landmarks. FAR bonuses can be earned for pre-identified improvement in the subway infrastructure. Learning from an earlier attempt at rezoning the area, the transit or public improvement required from the developer to obtain additional FAR will be clearly identified in a catalog included in the rezoning, increasing transparency. A number of landmark buildings would be eligible to sell transferrable development rights to developers and obtain part of the proceeds (the city would retain a portion of the proceeds).

Source: © Alain Bertaud. Used with the permission of Alain Bertaud. Further permission required for reuse.
**Value Realization**

Private sector investment, comprehensive master planning, and area promotion increase potential asset values. For example, growth on New York’s New West Side can be attributed to the success of the High Line, which spurred $2 billion of private investment, 12,000 new jobs, and 29 development projects since opening in June 2009. At both Hudson Yards and King’s Cross, developers came up with innovative master plans that included high-quality public space and local connectivity. Both projects involved dialogue between the public and private actors. Public participation was extensive in the King’s Cross development.

**Value Capture**

Higher asset values are captured for private profit and the public good. Private value capture is primarily via the rent or sale of new or enhanced housing, retail, or office units. The public sector uses a range of mechanisms to capture enhanced asset values realized by private actors. They include tax increment financing (TIF) and payment in lieu of taxes (PILOT) financing, both of which allow a municipality to sell bonds that are repaid with future tax revenues. Table 3.1 summarizes the main mechanisms of value capture.

### TABLE 3.1 Key Features of Selected Land Value Capture Instruments

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tax or fee based</strong></td>
<td></td>
</tr>
<tr>
<td>Property and land tax</td>
<td>Tax levied on estimated value of land or land and buildings combined. Revenues usually go into budgets for general purposes.</td>
</tr>
<tr>
<td>Betterment levies and special assessments</td>
<td>Surtaxes imposed by governments on estimated benefits created by public investments, so as to require property owners who benefit directly from public investments to pay for their costs.</td>
</tr>
<tr>
<td>Tax increment financing (TIF)</td>
<td>Surtax on properties within an area that will be redeveloped by public investment to be financed by municipal bonds, against the expected increase in property tax, which is pledged. Instrument mainly used in US.</td>
</tr>
<tr>
<td>Exactions/impact fees</td>
<td>Fees (or in-kind contribution) collected from private developers to pay for the cost of providing additional public infrastructure and services, and to accommodate additional population generated by their new development projects.</td>
</tr>
<tr>
<td><strong>Development based</strong></td>
<td></td>
</tr>
<tr>
<td>Land sale or land lease</td>
<td>Mechanism in which governments sell developers land for payment or land use right, in return for either an upfront leasehold charge or payments of annual land rent through the term of the lease.</td>
</tr>
<tr>
<td>Air right sale</td>
<td>Mechanism in which governments sell development rights extended beyond the limits specified in land use regulations (e.g., FAR) or created by regulatory changes to raise funds to finance public infrastructure and services.</td>
</tr>
<tr>
<td>Land readjustment</td>
<td>Mechanism in which landowners pool their land and contribute a portion of it sale to raise funds to partially defray public infrastructure development costs.</td>
</tr>
<tr>
<td>Urban redevelopment financing</td>
<td>Mechanism in which landowners, together with a developer, establish one cooperative entity to consolidate piecemeal land parcels into a single site that they then develop (e.g., high-rise building and/or mixed-use building) with new access roads and public open spaces. Local government modifies zoning codes and increases maximum floor area ratios in the targeted redevelopment district (typically around rail transit stations). Used mainly in Japan.</td>
</tr>
</tbody>
</table>

Source: Suzuki and others 2015.
Local Value Recycling

The captured value can be recycled, or reinvested, in the same development through public or private sector–led reinvestment. In the case of public sector–led reinvestment, increased public revenues captured from the private sector through higher local taxation, fees, and levies pay for additional government interventions within the same development area, reinforcing asset values and having positive social-economic impacts. The public sector offers private actors an opportunity to deliver community-oriented infrastructure directly, further increasing asset values and positive social-economic impacts.

As a result of these positive feedback loops, the area surrounding Hudson Yards is growing at a rate five times that of Manhattan as a whole. A report released in May 2016 (Related Companies and Oxford Property Group 2016) outlined the economic impact of the Hudson Yards development on New York City’s economy. It claims that once fully operational, the project will contribute nearly $19 billion a year to New York City’s GDP (accounting for 2.5 percent of the city’s output), generating nearly $500 million in annual tax revenues.

The Real Estate Benefits of Transit-Oriented Development

TOD enhances place value and in turn increases market potential value and real estate benefits. Cross-country evidence suggests that property prices are much higher when densities and walkability scores around station areas are high. Renne (2014) studied prices around 4,000 train stations in the United States. He finds that the average home in a TOD area (with high densities and high walkability) was worth about 3.5 times more than the average home in the United States and that home prices in these areas rose by twice as much as national home prices between 1996 and 2013 (box 3.3). Characteristics of the urban fabric such as density, use, and walkability thus determine the livability of a place, define its place value, and have a strong impact on real estate prices.

Notes

1. The cities of Baltimore, Denver, and Portland explicitly consider market potential values in their public policies.
2. This chapter draws on the value framework and policy recommendations developed in Huxley (2009).

References

Renne (2014) calculates the differences in property prices between homes in TOD and transit-adjacent development (TAD) areas of the United States. (TOD areas are defined as walkable, mixed-use, dense communities within 800 meters of a train station. TAD areas are defined as areas around stations characterized by low-density, automobile-oriented land use.) Research indicates that gross housing densities should be at least 4,000 households within an 800-meter radius of a station in order to support transit ridership. Walkscore.com rates communities with a 70 or higher score (out of a possible 100) as “very walkable”; it rates areas with scores above 90 as “walkers’ paradise.”

Renne’s TOD Index provides a new benchmark to track both home and rental prices in station areas across the United States. It includes stations in TOD, TAD, and hybrid areas. Each category is benchmarked against the national Zillow Home Value Index (ZHVI) or the national Zillow Rent Index (ZRI).

The study analyzes 4,000 passenger train stations, 1,441 of which meet TOD criteria of density and walkscore. Another 1,180 are hybrids, meeting the criteria of density or walkscore but not both. Some 1,775 stations are categorized as TAD areas, which meet neither criterion.

Assuming a price index of 100 in 1996, the index for home located in a TOD district was 400 in 2013, and the index for the home located in a TAD district was 225 (box figure 3.3.1). Assuming a rental index of 100 in 2012, the increase in the rental price of the home located in a TOD district was 18 percent; the rent in the TAD district rose by just 11 percent (box figure 3.3.2).

Source: Renne 2014.
BOX 3.3  How Does Transit-Oriented Development Affect Home Prices? (continued)

BOX FIGURE 3.3.2 Index of Rents in Various Types of Areas, January 2012–July 2014

Source: Renne 2014.


Using Good Urban Design of the Public Realm to Create High Place Value

Good urban design creates place value that fosters urban economic growth. It supports increased density and ensures that people do not find congestion and density oppressive. It complements the planning approach presented in chapter 2. It includes significant streetscape improvements that make streets places for people; creates a spirit of place; makes the city more legible; and provokes a feeling of enclosure, human scale, coherence, image (see photo 4.1), and linkage.

This chapter focuses on urban qualities that create place value. The first two sections describe these qualities. The third section illustrates them with three case studies of good urban design that contributed to significant increases in market value.

Positive and Negative Space

Numerous perceptual qualities affect reactions to a place. They include the walking experience, the sense of safety, the sense of comfort, and the level of interest. To achieve walkability, urban designers should achieve “spirit of place,” enclosure, human scale, layering of space, complexity, coherence, legibility, and linkage, the eight qualities examined below.

Urban design shapes perceptions of places and sequences of spaces. Negative spaces are empty spaces left between buildings without shape, sense of direction, or purpose. They do not sustain human interest even if benches and amenities are provided. Good urban design provides positive space—space with an identifiable...
shape and direction. “An outdoor space is positive when it has a distinct and definite shape, as definite as the shape of a room, and when its shape is as important as the shapes of the buildings that surround it” (Alexander, Ishikawa, and Silverstein 1997). Positive space traditionally comprised not only streets, squares, and gardens but also the interiors of large buildings, such as courtyards of palaces and interiors of churches. There was no separation between street and buildings but rather a continuum of public space, the stage of urban life.
Map 4.1 contrasts the positive public space in 18th century Rome with the disconnected public space of Brasilia. The map of Rome, drawn by Giambattista Nolli in 1748 (panel a), shows how the continuity and positivity of public space creates the high place value of traditional European cities. It reveals no division between interior and exterior spaces or between solid masses and empty spaces. The black areas show the continuous public space of streets, squares, large churches, and palace courtyards; the white areas show the compact mass of private buildings. In the map of Brasilia (panel b), the continuous public space is replaced by formless empty space between buildings—a space divested of its positivity that becomes pure negativity, creating no place value.

Streets and squares are the basic elements around which cities should be organized; for most people, they constitute the very essence of the phenomenon “city.” In recent years, planners have made good use of streets (based on the linear pattern of human movement) and squares (based on the eye’s ability to survey an area) to improve urban design. In contemporary developments such as Canary Wharf, King’s Cross, and the Beddington Zero Energy Development (in London); Hudson Yards (in New York); and Hammarby Sjöstad and Malmö (in Sweden), the positive qualities of the public space have contributed to place value.

**Eight Urban Qualities that Create High Place Value**

Cross-country evidence and the analysis of numerous positive public spaces, historical and contemporary, suggest that positive space can be achieved when urban designers endow space with eight key urban design qualities.¹
Genius Loci (Spirit of Place)

Genius loci (spirit of place) is the quality of a place that makes it distinct and recognizable, a place one remembers. Image plays to the innate human ability to see and remember patterns. A memorable place is created when distinct elements are easily identifiable and grouped into an overall pattern (Lynch 1960).

Landmarks are a component of spirit of place. What is essential is their singularity and location in relationship to the context and the city. Landmarks act as visual termination points, orientation points, and points of contrast in the urban setting (photo 4.2). They give identity and structure to the urban space around them.
Spirit of place is related to sense of place. A visual theme contributes to a cohesive sense of place and inspires people to enter and rest there (Cullen 1961). Iconic architecture and human-scale passages characterize the Beddington Zero Energy Development, in London (photo 4.3) and the Queen Elizabeth II Great Court, the largest covered square in Europe, at the center of the British Museum (photo 4.4).

**Enclosure**

**Enclosure** refers to the degree to which buildings, walls, trees, and other vertical elements define streets and other public spaces. These vertical elements interrupt viewers’ lines of sight. A sense of enclosure results when lines of sight are so decisively blocked as to make outdoor space seem room-like. Spaces where the height of vertical elements is proportionately related to the width of the space between them have a room-like quality.

“Enclosure, or the outdoor room, is, perhaps, the most powerful, the most obvious, of all the devices to instill a sense of position, of identity with the surroundings…. It embodies the idea of here-ness” (Cullen 1961). In an urban setting, enclosure is formed by lining the street or plaza with unbroken building fronts of roughly equal height. The buildings become the “walls” of the outdoor room; the street becomes the “floor”; and, if the buildings are roughly of equal height, the sky becomes an invisible ceiling. The total width of the street (from building to building) should not exceed the building heights, to maintain a feeling of enclosure. Box 4.1 illustrates the impact of such enclosure on the quality of public space.

Enclosure is eroded by breaks in the continuity of the street wall. Breaks filled by nonactive uses (vacant lots, parking lots, driveways) and large building setbacks create dead space. “Building setbacks from the street have actually helped greatly to destroy the street as social space” (Alexander, Ishikawa, and Silverstein 1977).

**Human Scale**

**Human scale** refers to the size, texture, and articulation of physical elements that match the size and proportions of people and correspond to the speed at which people walk. For pedestrians the information field offered by public space should be scaled to offer rich and coherent information at a pace of five kilometers per hour.

Building details, the pavement texture, street trees, and street furniture all contribute to human scale. Moderate-size buildings, narrow streets, and small spaces create an intimate environment; large buildings, wide streets, and large open spaces create the opposite effect.

Distance plays an important role in personal interaction. At 300–500 meters, people can identify other people as humans instead of objects. At 25–100 meters, they can identify individual characteristics and body language. At less than 25 meters, richness of detail and communication intensify dramatically meter by meter (Alexander, Ishikawa, and Silverstein 1977). These distances set the limits of human scale and the perceived quality of the human space. Decisions at the large scale (city and regional planning); the medium scale (site planning); and the small scale (the immediate environment) are inseparably linked. This interrelationship is
important because the small scale is where people meet and evaluate decisions made at all planning levels. Almost all of the most highly regarded public squares in Europe are less than 10,000 square meters; most are less than 8,000 square meters (box 4.1). The battle for quality in cities and building projects must be won at the very small scale.
BOX 4.1 Enclosure and Scale of Public Spaces: Madrid Plaza Mayor Versus Nanchang Ba Yi Square

Madrid’s major civic space, the Plaza Mayor (built in the early 17th century), is a well-defined, 122 x 91 meter rectangle the size of an urban block. The square is lined with uniform houses, each with a stone arcade at the street level, three brick floors, and an attic. The streets, which existed before the square was built, lead to the square in an irregular fashion, but this irregularity is masked by the uninterrupted line of porticos at the places where these streets open onto the square (box photos 4.1.1 and 4.1.2 and box map 4.1.1). This plaza is now a major tourist attraction in Madrid.

BOX PHOTO 4.1.1 Sense of Enclosure at Madrid’s Plaza Mayor

BOX MAP 4.1.1 Street Connections to Madrid’s Plaza Mayor

Source: © Françoise Labbé. Used with the permission of Françoise Labbé. Further permission required for reuse.

Source: Salat, with Labbé and Nowacki 2011.

BOX PHOTO 4.1.2 Street Connections to Madrid’s Plaza Mayor

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Ba Yi Square, in Nanchang, China, creates a very different effect. The square lacks edge definition, with the major roads around it eliminating any sense of enclosure (box photo 4.1.3). The square fails to give a coherent order to oversized roads and disparate buildings. The square’s size (515 x 255 meters, the size of a Chinese superblock) erodes human scale, compared with Plaza Mayor, seen at the same scale within a 800 meter square selection of urban fabric in box photo 4.1.4.
Layering of Space

Layering of space refers to the degree to which people can see or perceive what lies beyond the edge of a street or other public space. Physical elements that influence layering of space include walls, windows, doors, fences, landscaping, and openings into midblock spaces. The Barcelona Museum of Contemporary Art (photo 4.5), designed by Richard Meier, illustrates the concept of transparency and layering by articulating two public squares and a complex composition of historic and modern architecture, materials, and volumes, with a great sense of space layering.

Whether the public environment invites or repels people depends on its degree of enclosure and transparency and the way in which the border zone is designed. Flexible boundaries in the form of transitional zones function as connecting links, making it easier physically and psychologically for people to move between in and out. Contact through experience between what is taking place in the public environment and what is taking place in the adjacent residences, shops, offices and communal buildings provides an extension and enrichment of possibilities.

Complexity

Complexity refers to the visual richness of a place. It depends on the variety of the physical environment—the number and kinds of buildings, the landscape elements, the street furniture, and human activity.
 Complexity is related to the number of noticeable differences to which a viewer is exposed per unit of time. Narrow buildings in varying arrangements add to complexity; wide buildings subtract from it. People need many different surfaces over which light is constantly moving in order to keep their eyes engaged. Changes in the textures, widths, and heights of buildings, as well as building shape, articulation, and ornamentation, add to complexity.

Complexity supports walking (photo 4.6). Pedestrians require a high level of complexity to hold their interest. An interesting walking network makes the walking distance seem shorter by dividing the walk into manageable stages. Crucial to determining the acceptable distance in a given situation is not only the physical distance but also the experienced distance. People find a 500-meter along an uninteresting broad arterial very long and tiring; the same walk can be experienced as a very short distance if the route is perceived in stages (Ewing and Bartolomew 2013).

Complexity is not only a physical attribute of the urban fabric.¹ It is also a social process of human interactions that is self-reinforcing (Gehl 2008). When one person does something, others often participate or observe. Individuals and events thus influence and stimulate one another. Once this process begins, the total activity is nearly always greater and more complex than the sum of the component activities.

People and events are assembled in time and space so that individual activities get a chance to grow together to become larger, more meaningful, and inspiring sequences of events. Something happens because something happens. Larger, more complex community activities develop naturally from many small daily activities (box 4.2).

**Coherence**

Coherence refers to a sense of visual order. The degree of coherence is influenced by consistency in the scale, character, and arrangement of buildings, landscaping, street furniture, paving materials, and other physical elements (photo 4.7). “Geometrical coherence is an identifiable quality that ties the city together through form and is an essential prerequisite for the vitality of the urban fabric” (Salingaros 2000).
BOX 4.2 Complexity and Life between Buildings

The system of squares around the Centre Georges Pompidou (a modern art museum) in Paris includes a wide, sloping square (the piazza) in front of the center’s main facade; a deep square (Place Igor Stravinsky); Eglise Saint-Merri; and the Stravinsky fountain (box map 4.2.1). A third small square (Place Edmond Michelet) creates a transition between Boulevard de Sébastopol and the piazza in front of the museum. This system of three interlocking squares support many social activities, including regular performance.

BOX MAP 4.2.1 System of Squares at the Centre Georges Pompidou, Paris

Source: Salat, with Labbé and Nowacki 2011.

BOX PHOTO 4.2.1 System of Squares at the Centre Georges Pompidou, Paris

Source: © Françoise Labbé. Used with the permission of Françoise Labbé. Further permission required for reuse.
Legibility

When faced with a new place, people automatically create a mental map that divides it into paths, edges, districts, nodes, and landmarks (Lynch 1960). Legibility refers to the ease with which people can create such a mental map so that the spatial structure of a place can be understood and navigated as a whole. Street or pedestrian networks that provide a sense of orientation and relative location and physical elements that serve as reference points improve legibility (photo 4.8).

PHOTO 4.7 Coherence of Vienna’s Building Fabric

Source: © Françoise Labbé. Used with the permission of Françoise Labbé. Further permission required for reuse.

PHOTO 4.8 Oslo Opera House

Source: © Françoise Labbé. Used with the permission of Françoise Labbé. Further permission required for reuse.
Linkage

Linkage can be defined as features that promote the interconnectedness of places and provide convenient access between them. It refers to physical and visual connections—between buildings and the street, between buildings, between spaces, between one side of the street and the other—that unify disparate elements. Linkage can occur longitudinally along a street or laterally across a street. The fact that the possibilities for seeing other people and events is limited to a distance of 25–100 meters places great demands on the degree of linkage (Ewing and Bartolomew 2013). The High Line in New York, Marina Bay East Gardens in Singapore, and the bridge to St Paul in London (photo 4.9) are example of such linkages.

Example of Application of All Eight Design Elements

The proposed Green Triangle in Tianjin, a major port city in northeastern China, illustrates how all eight design elements could be applied. The conceptual design for the project was developed as part of a World Bank workshop in June 2014 to illustrate the concepts presented in this chapter in a real case. At this stage, it is not expected to be built.

The Golden Triangle area is located in the center of Tianjin, where green space is surrounded by a residential neighborhood to the north, mixed use to the east, and a commercial center to the south. The area has planned stations for two metro lines and a bus rapid transit line. It covers 1.6 hectares and allows for a maximum FAR of 4.1 and a maximum plot ratio of 60 percent.

The vision for the Golden Triangle is to combine new building space with green space, to turn it into a “Green Triangle” (image 4.1). The area would be highly...
IMAGE 4.1 Architect’s Sketches of Tianjin’s Green Triangle

a. View from above

b. View from the southeast

c. View from the north

Source: Serge Salat, architect, for the World Bank.
permeable, with six openings in a medium-size block leading to an inner public space where passengers can meet. A garden roof would link the different levels. The garden roof and the inner green triangular square recreate the same amount of green space as in the original site.

The Tianjin Green Triangle’s unique combination of an elevated garden promenade, a green amphitheater, and a green triangular plaza would offer the opportunity to create a reference point at the entire city scale: an urban experience associating the space of movement (transit stations) and places for people (streets, green roofs, the green amphitheater and enclosed plaza, the sharp triangular tower) as an icon of green 21st century Tianjin. The project would avoid isolated buildings, arterials, and other disconnected and inanimate objects, instead connecting people through place-making and multiple experiences in a complex sequence of movement within a structured place where people pursue a wide variety of activities.

The project's physical structure would support the social structure by linking indoors and outdoors at various levels. It would offer flowing, gentle transitions between various categories of public spaces. Its physical structure would reflect and support the desired social structure, encouraging innovation and creativity and contributing to creating high place value.

The conceptual design of the Tianjin Green Triangle embodies the eight urban design qualities for creating high place values:

1. **Spirit of place**: The triangular patterns of the project capture attention and create a lasting impression. The triangular landmark tower creates a strong image by its singularity and location in relationship to its context and to the city at large. It is a visual termination point, an orientation point, and a point of contrast in the urban setting.

2. **Enclosure**: Buildings, walls, and streets define the “Green Agora.” The height of the vertical elements, which is proportionally related to the width of the space between them gives, the agora a room-like quality. The buildings become the “walls” of the outdoor triangular room, the plaza the “floor,” and the sky an invisible “ceiling.”

3. **Human scale**: The size, texture, and articulation of the Green Triangle’s physical elements match the size and proportion of people and correspond to the speed at which people walk. Moderate-size buildings and sequences of small spaces create an intimate environment. The Green Agora is within the 100-meter limit that allows people to see everything that happens.

4. **Layering of space**: Many entryways in the Green Agora contribute to the perception of human activity beyond the street and foster interactions between indoors and outdoors. The Tianjin Green Triangle assembles people and functions in time and space. It integrates, invites, and opens up rather than close in activities.

5. **Complexity**: The project provides complex walks, split into sequences, at various levels along the edges of the Green Agora. Movement at the edge of a space makes it possible to simultaneously experience both the large space and the small details of the building facades or the spatial boundary along which one walks.

6. **Coherence**: The project displays a high level of formal and geometrical coherence, as the urban block is carved into smaller components following a set of consistent principles.
7. **Legibility**: The project’s spatial structure provides a sense of orientation and relative location by physical elements that serve as reference points. The Green Triangle increases the clarity of the cityscape, the ease with which its parts can be recognized and organized into a coherent pattern.

8. **Linkage**: Tianjin Green Triangle is intensely linked by roof bridges and a continuous architectural promenade unfolding on several levels (see image 4.1, panel c). The block is divided into buildings separated by openings and united by the continuous elevated gardens and their bridges. These green connections link people and events.

**Case Studies of Urban Design that Creates High Place Value**

This section examines three cases studies (two from Sweden and one from Singapore). All three cases used increases in connectivity and high-quality urban design to spur green development.

**High-Quality, Eco-Friendly Urban Design and Transit Connectivity in Hammarby Sjöstad, Sweden**

Hammarby Sjöstad, in Stockholm, implemented an integrated approach to district planning that incorporates sustainable resource use, ecological design, and low-carbon transport (photo 4.10). Its success can be attributed to strong environmental goals that shaped the development plan, which covers land use, transportation, building materials, energy, water, and sewage.

The 160-hectare district was built on a former industrial and harbor brownfield area located on the south side of Hammarby Lake, three kilometers south of the Stockholm city center. Its flexible grid of small blocks incorporates public green space and streets designed as places for people.

Hammarby Sjöstad is an example of the conversion of a run-down industrial area into a modern, environmentally sustainable, mixed-use district with good public transit connections and high-quality urban design that embodies the eight urban qualities described in the previous section. Redevelopment of this industrial waterfront used the dynamics of place and node value increase to raise market potential value.

Planning for the redevelopment of the site began in 1996. The goal was to build a sustainable community that is twice as energy and resource efficient as a typical one. The Hammarby model (figure 4.1) is a unique eco-cycle system that systematically seeks out opportunities to reuse energy, solid waste, water, and wastewater from homes, offices, and other structures in the area in an integrated manner. It is the district’s attempt at a balanced “closed-loop urban metabolism.” Urban metabolism is a model to facilitate the description and analysis of the flows of materials and energy within cities. It provides researchers with a framework to study the interactions of natural and human systems in specific regions. In a circular metabolism, there is nearly no waste and almost everything is reused. (Wachsmuth 2012).
PHOTO 4.10 Use of Water at Several Scales in Hammarby Sjöstad, Sweden

Source: © Françoise Labbé. Used with the permission of Françoise Labbé. Further permission required for reuse.

FIGURE 4.1 The Hammarby Model

Urban-scale density, access to multiple modes of transit, an emphasis on reduced car commuting, preservation and restoration of existing natural systems, and progressive construction and housing policies make Hammarby Sjöstad an effective demonstration of integrated planning. Through the city’s forethought in land acquisition, the planning department was able to efficiently coordinate transportation, land use, and development.

**Integrated transportation and land use**

Hammarby Sjöstad had three transportation goals:

- Eighty percent of residents’ and workers’ journeys would be made by public transit, bike, or foot.
- At least 15 percent of households would have car-sharing memberships, and at least 5 percent of workplaces would have car-sharing memberships.
- One hundred percent of heavy transportation by vehicles would meet environmental zone requirements (Fränne 2007).

The district’s planner recognized the importance of integrating transportation and land use planning. Expansion of the district was therefore complemented by transport investments, including increased bus service, cycle paths, pedestrian bridges, ferry service, and extension of the tram line.

Hammarby Sjöstad was designed to integrate transportation, amenities, and public spaces. The spine of the district is a 37.5-meter wide boulevard and transit corridor that connects key transport nodes and public focal points and creates a natural focus for activity and commerce (Foletta 2011). Hammarby Sjöstad’s tram-line was built as the main commuting traffic mode to the southern part of Stockholm. Underground parking and low parking ratios mean that cars do not dominate the urban landscape.

**The planning process**

The first step in planning was the development of the strategic master plan, led by architect Jan Inghe-Hagström, at the Stockholm City Planning Bureau. The plan is divided into 12 sub-neighborhoods, which are being developed in phases. A process called “parallel sketches” is used in which the city selects three to four private sector architects/planners to draw up detailed proposals for a sub-neighborhood. The city evaluates each of the sketches and combines the best features to create a master plan. The city planning and design team then prepares a design code for each sub-neighborhood in partnership with the developers and architects. This design code is included in the development agreement between the developer and the city. The design code is taken through the local authority political process in order to grant planning permission; the code provides an overview of the layout, form, and structure of each block, including key landmark buildings, public spaces, and pedestrian routes.

To provide architectural diversity, and inspire higher standards of design through competition, a consortium of developers and architects is then invited to develop each plot or individual building within the sub-neighborhood, according to the design code. More than 60 developers and 30 architects were...
involved in the planning process (Foletta 2011). This participatory process helped the project achieve a high level of diversity and complexity within a coherent master plan.

Application of the eight design principles

*Spirit of place* has been created in Hammarby Sjöstad by the subtle use of Stockholm urban morphology, sizing, and scaling. The variety of urban tissues in Stockholm helped guide the urban design. Although Hammarby Sjöstad is located outside Stockholm’s center, the design is intentionally urban rather than suburban and follows the urban fabric typology of Stockholm’s center city (image 4.2), with 4 types of landscape and 5 types of public waterfront, 12 different types of urban tissue and as many street profiles (Assche and Meeus 2000). The traditional city structure of Stockholm has been combined with a new architectural style that responds to Hammarby Sjöstad’s waterside context, promotes the best of contemporary sustainability technology, and follows modern principles of maximizing light and views of the water and green spaces.

*Enclosure* of a variety of inner spaces is subtly combined with openness and linkage by multiple water and pedestrian connections. The facades form a concave, complex, and irregular enclosure of pedestrian areas, giving a sense of rhythm, diversity, and variety to the pedestrian experience. Bridge curves give rhythm to the pedestrian journey.

**IMAGE 4.2 Urban Block Pattern of Hammarby Sjöstad, Sweden**

Source: Assche and Meeus 2000. © van Assche. Used with the permission of van Assche. Further permission required for reuse.
Human scale is created by an urban morphology (form and structure) using urban block patterns and sizing of the center city. The district was planned with a dense settlement structure, with four- to five-story buildings in a compact neighborhood complemented by spacious green courtyards. The design follows standards for Stockholm’s center city in terms of street width (18 meters), block size (70 x 100 meters), density, and land use. City street dimensions, block sizes, building heights, and density mix are integrated with openness, waterfront views, parks, and sunlight. This design allows for both wind-shielded and sunny inner courtyards, with ample possibilities and incentives to develop inviting entrance and common courtyard greens and facilitate small-scale cultivation in micro-garden plots and small greenhouses.

Layering of space is ensured by limited building depths, recessed penthouse flats, large balconies and terraces, and large windows on water-facing facades. Most balconies overlook streets, waterfront walkways, and open spaces. Many apartments also have a semi-open block form, providing open access to the courtyards of the residential blocks.

Complexity, coherence, and legibility are created by the planning process. A master plan resulted from the combination of multiple sub-neighborhood plans; implementation fostered diverse designs respecting the design code. Among the key organizing principles is the variety in the scales of development. The scale of development varies from four- to five-story buildings along the Sickla Canal and six- to eight-story buildings along the main corridors. Taller buildings facing the water are built in a classic urban style that complements the large-scale facilities and large open water areas. Large-scale, multifunctional buildings have been built along the avenue, with small-scale backstreet and courtyard houses built between the dock and the park walkway. The environment along the canals is more intimate and small-scale, with development gradually downscaled toward the shorelines (photo 4.10).

Linkage is ensured in multiple ways. The water environment adds significant links in the neighborhood. Major non-road-based links create huge areas of openness linked to building spacing and height. A network of connected parks, green spaces, and walkways runs through the district to provide a counterbalance to the dense urban landscape. Two wide bridges over a busy road have been covered with vegetation. The bridges provide both a link and a shortcut to the nature reserve just outside the city.

Enhancement of the social life of the community
Mixed-use development creates a complete and balanced community. The 200-hectare district is home to about 20,000 people (9,000 housing units) and 10,000 jobs (200,000 square meters of commercial space). It offers a wide range of educational, cultural, and recreational programs. It balances both private and public space and ensures that priority is placed on what benefits the community. High-density living promotes a greater sense of community by facilitating the development of programs and processes that promote social interaction and cultural enrichment. Family living is key to Hammarby’s success, with good-quality housing and community facilities for families, including schools, community center, and churches.
The development process and market potential value

The city of Stockholm joined forces with 25 construction companies to build the district, with the district contributing 80 percent of local cost. Other funding came from two government agencies, the Swedish Rail Administration (rail transport) and the Swedish Road Administration (routing of the Southern Link ring road).

Several key features ensured an efficient development process, with a good balance between planning and market forces (Lee n.d.). The entire site is owned by a single owner. As a result, the plan could be implemented in an orderly fashion. It was based on a master plan reflecting a long-term vision. Major public funding of infrastructure was key, with power, water, and recycling facilities all put in place early. Each development zone was put out to developers and architects, who came up with solutions. Within the confines of the master plan, different developers delivered each zone, creating diversity. Requiring developers to pay for each site on a per-square-meter-of-development basis sharpened the focus on design and quality. The master plan envisaged a mix of nonresidential uses but did not impose constraints. Ground floor areas in certain key frontage zones had to be active (including shops, for example), but were flexible for the end-user. The market eventually determined what worked.

Hammarby Sjöstad is now a middle-class suburb with strong housing values (which increased by four to five times since the first parts were built). It also includes affordable housing, public rental, private rental, and privately owned properties.

Lessons learned

A holistic approach to planning, grounded in increased connectivity, high-quality design, and strong environmental goals can help shape new developments and create market potential in run-down industrial areas. These principles should be adopted as early as possible, so that they can be integrated into every part of the infrastructure early in the planning process. Achieving both coherence and a high level of complexity and diversity in the neighborhood requires a participatory process that includes all stakeholders and a discussion of possible options and their potential results within the planned district.

Transit-Oriented Development and Green Growth in Malmö, Sweden

Like Hammarby, the Bo01 district of Malmö was built on a former industrial estate and port, where the ground was polluted (map 4.2). This 18-hectare development represents the first step in the process of transforming the 160 hectares of industrial estate and port of Västra Hamnen, one of Malmö growth areas. Density is 122 people per hectare, but more than half of the development area is dedicated to open space, making Bo01 an example of an urban settlement that does not diminish quality of life for the sake of density.

Bo01, the first area of the Western Harbor being constructed (inaugurated in 2001 for the housing exhibition Bo01), combines transit-oriented development (TOD) features with green growth. Comprehensive planning for energy, water, and waste systems resulted in significant improvements, especially in energy usage.
production (all of which comes from renewable sources) and solid waste management.

Bo01 inhabitants are encouraged to use environmentally friendly modes of transport. The area is car free. It is well served by paths dedicated to pedestrian and bicycle use. A little more than eight kilometers of bicycle paths extend from Bo01 through the Western Harbor. All residents of Bo01 are within 450 meters of a bus stop, and buses operate every seven minutes (City of Malmö 2006).

Malmö has more than 460 kilometers of bicycle paths. Forty percent of trips to school or work are made by bicycle, and 30 percent of all trips are by bicycle (Reepalu 2013).

Application of the eight design principles
Outstanding urban design qualities have been achieved through an innovative participatory planning process in which the city exerted control through ownership, goal formulation, and planning while involving stakeholders. The city hired Klas Tham, a well-known architect and planner, to craft the design and planning basis for Bo01 and serve as its main designer and director. Tham balanced the technological goals of the project with an overarching concern for the social environment and for elevating the aesthetic quality of the development (Austin 2013). According to Tham:

The plan has also been shaped by our ambitions: to offer an urban structure that is sufficiently robust, to meet the demands of an uncertain future (the network...
structure of block city and clear borders between the public and private spaces), to provide the conditions for the essence of the city, the meeting between different people and cultures, to come about gradually (the small-scale property division of the plan, its range of different residential environments), to let cars get through, but on the terms of the pedestrians, to provide the conditions of a city environment which, over and above empathy and comprehensibility, also offer a wealth of information, mystery, surprises, and many unique and promising urban spaces; a dramatic tension between the grand and the intimate, to offer a wealth of all forms of vegetation, from the individual garden, to the sheltered, thickly wooded public canal park through the interior of the area. That is how the plan took shape. The grid has been distorted by the wind, among other things, like a fishnet hung out to dry. And, as a result, it has actually become more rational, more valuable to build, live and stroll around in. (McCollum n.d.)

Innovative planning methods that emphasized the collaboration of government, designers, and developers were created through “creative dialogues” to produce consensus on what could be accomplished under a time constraint. The result was the Quality Program (1999), a simple document outlining the minimum standards for architecture, landscaping, energy, water, waste management, and biodiversity. It included an emphasis on green space, which reinforces the master plan and resulted in diverse and effective landscapes (City of Malmö 2002). Dialogue fostered an atmosphere of collaboration and innovation. The 20 developers selected for the project committed to material, technological, environmental, and architectural quality measures before any parcel was sold. Although time-consuming, the process resulted in rapid approval of the plans developers submitted to the city (Austin 2013).

**Spirit of place** is created in Bo01 by the “sensory, emotional and mental nonquantifiable human aspects of design” and by “highlighting the genius loci—the unique identity and quality of the place—the sky, the sea, the wind, the ground—and its imageability,” according to the Quality Program (1999). According to Klas Tham:

The plan has been sculpted by the grandeur of the site (the ocean, the expanse of sky, the horizon, the sunset), by very strong exposure to the wind from the west, and by the broad-meshed grid of boulevards in the district. This ensures orderliness and empathy on a grand scale and at the same time, gives space to discover a teeming, less tangible world on the inside of the large squares. (McCollum n.d.)

Water is included in park axes and as stylized streams of storm water in squares, piazzas, streets, and lanes. It creates natural limits and structures people’s movement. Bridges, canals, and courtyards organize journeys with views of water. The Turning Torso Tower (see photo 4.1) acts as a landmark, creating place identity.

**Enclosure** of a variety of semipublic courtyards and small squares—linked by green spaces, including parks and streets—provides vitality, light, room to travel, and room to rest.

**Human scale** and the interaction of man with the environment are fundamental factors in the Quality Program (1999):

It is human beings and their needs that provide the starting point for all design and all planning and never, for example, the needs of motor traffic or technology…. A district needs values which cannot be measured in the traditional manner: visual and acoustic impressions, the experience of greenery and water, street
spaces with “human” proportions, and the subconscious understanding, interpretation and experience of one’s surroundings in a way which interacts positively with our biological origins, even in the distinctively manmade environment of the city.

Slightly more than half of the area is open space; many social spaces were designed within a diverse landscape to create a broad range of experiences for people. Access to green areas and water, the use of daylight, and various visual impressions create a sense of well-being (photo 4.11).

Layering of space is ensured by intermediary transparent components that are open to the outside, such as porches and balconies, to ensure transitions between public and private areas. Public space is not designed as a homogenous entity in opposition to private space but as a series of intermediary semiprivate and semipublic levels.

Complexity is defined in the Quality Program (1999) as the “wealth of information, mystery, surprise, possibilities of getting lost and making accidental discoveries.” It is created by irregular streets and their rich set of interconnections, visual variety, diversity in patterns, open spaces, and buildings.

The Bo01 plan develops a rhythm of moving and stopping. It is made for the slower pace of pedestrians and cyclists. Variations in the grid shield inner areas from the weather that buffets the district. Unpredictable building orientation and placement create a dynamic character, full of surprising spaces and views within a pedestrian environment.

Diversity characterizes the area. Twenty-six architectural firms designed the houses, each firm given wide freedom of expression. Twenty developers built

PHOTO 4.11 Integration of Water Features in the Bo01 Neighborhood of Malmö, Sweden

Source: © Françoise Labbé. Used with the permission of Françoise Labbé. Further permission required for reuse.
houses and apartments of different sizes and types of ownership. Bo01 created a community with the variety, detail, and diversity that elude master-planned communities with fewer participating architects, landscape architects, and developers.

The project also reveals diversity and variety in the design of its parks. The Scania Portal (Scaniatorget) includes etched pathways that allow storm water to reach the sea with an austerity and restraint reminiscent of Zen gardens. In contrast to typical seaside parks, with their hardened, protective edges, Anchor Park offers more detail and an introverted character than the dramatic views and scale of the western landscapes (Dania Park, Scania Portal, the Promenade, and Scania Park).

**Coherence** within this high level of diversity is ensured by a strong overarching order in the detailed development plan with “distinct territories, clear boundaries between what is to be perceived as, respectively, public and private, between semiprivate and private, between private and private” (Bo01, the City of Malmö, and Developers’ Representatives 1999). The architectural design is integrated with and supportive of the structure of public spaces. The design of the facades overlooking quays, parks, and main streets proclaims the buildings as the walls of very important urban spaces. The tall houses on the block perimeter form a wind shelter around a small-scale and green interior.

**Legibility** in Bo01 is defined as “strong, intrinsic identity of the part and the whole—the home, the block, the street, the square, the park, the neighborhood; intelligibility of structure, form and function, facilitating participation by the local residents” (Bo01, the City of Malmö, and Developers’ Representatives 1999). Urban edges ensure this intelligibility (photo 4.12). The neighborhood has a clearly defined limit, with the sea forming a natural border.

**Linkage** was developed at many scales. It is both formal and informal and includes a mix of streets, pedestrian walks, alleyways, squares, and water banks. As stated in the Quality Program (1999), the plan “provides many different opportunities for approaching and exploring the district. A network of axes moving through different, carefully balanced public spaces will provide oppor-
tunities for many different choices of direction and experiences.” A central axis extends from the city castle toward the sea. This tree-lined avenue is the symbolic main entrance to the Western Docks; it creates visual contact between the castle and the sea. At right angles to this axis, a canal and street access link the docks in the Wihlborg area with new housing on the Bo01 site. The cross formed links and articulates four city quadrants with different characteristics and content.

Another layer of linkage is the variety of informal pathways where people can stroll and bicycle. They complement the neighborhood street pattern with a rich network of pedestrian connections. The use of these varying interior open spaces facilitates many social interactions and is of great importance in creating a character for the area as a whole.

Lessons learned
The holistic definition of sustainability by the visionary planner resulted in aesthetics and social opportunities that match the high levels of technical performance. The project supports physical and psychological health by providing immediate access to open space, walkable neighborhoods, and opportunities for social interaction. The urban environment offers natural meeting points and a well-balanced mix of housing activities, schools, and green areas, creating a vibrant community fulfilling the needs for beauty, proportion, nature, water, and safety.

The Positive Feedback Loop of High Node, Place, and Market Values in Marina Bay, Singapore

Singapore’s desire to become a financial hub economy meant that it needed to build new, high-quality commercial space. Urban regeneration and “breathing space” was needed in the central business district (CBRE 2012).

PHOTO 4.13 Singapore’s Marina Bay Skyline from the East

Source: Chensiyuan. GNU Free Documentation.
Marina Bay became the new growth area (photo 4.13). The 360-hectare area was reclaimed during the 1970s and 1980s, in anticipation of the growth of the city center. Full development of this area is expected to more than double Singapore’s office size, to 4.8 million square meters.

**High node value**
Marina Bay is planned as a vibrant, mixed-use district with round-the-clock activities based on sustainable development strategies. By 2018 the area will be served by four mass transit lines and nine metro stations; all locations in Marina Bay will eventually be within a five-minute walk of a public transit node. Singapore’s Urban Redevelopment Agency projects that the intricate network of mass transit lines, cycling paths, and pedestrian walkways serving the district will make the need for car redundant in this part of the city. It is the first district in Singapore to be planned upfront with a network of dedicated cycling lanes. A comprehensive pedestrian network, including shady sidewalks, covered walkways, and underground and second-story links, will ensure all-weather protection and seamless connectivity between developments and transit stations. Water taxis will also operate.

**High place value**
To provide good connectivity and seamless extension, the development parcels were planned based on an urban grid pattern with floor area ratios of 8–25 that extends from the existing street network within the central business district. This grid creates a flexible framework with a series of land parcels that can be combined or subdivided to meet new requirements or changing demands and allow the phasing in of development.

The vision for Marina Bay is “a garden city by the bay.” It is Singapore’s first location to host water activities and serve as a focal point for major events. Together with the waterfront promenade and its loop of attractions and vibrant public spaces, Gardens by the Bay is playing a key role in defining the character of Marina Bay, with its leafy streetscape, lush park, and sky-rise gardens.

Gardens by the Bay is a nature park spanning 101 hectares of reclaimed land adjacent to the marina reservoir. The park consists of three waterfront gardens, the largest of which is 54 hectares. It is part of a strategy to transform Singapore from a “garden city” to a “city in a garden.” The aim is to raise the quality of life by enhancing greenery and flora in the city. Gardens by the Bay includes “super-trees”—tree-like structures 25–50 meters high. These vertical gardens perform various functions, providing shade, venting hot air, and circulating cool water (photo 4.14)

**High market potential value**
Public sector investment has been key to the development of Marina Bay. This investment has been recouped by returns from the private sector. The Urban Redevelopment Agency has received more than $4.5 billion from the sale of land parcels (excluding proceeds from One Marina Boulevard and the M+S Marina One development site), according to estimates by CBRE (2012). Public sector investments in infrastructure have attracted local developers as well as
Transforming the Urban Space

developers from Australia; Hong Kong SAR, China; Malaysia; and the United States. U.K. firms reportedly occupy 29 percent of the development’s space, with 19 percent occupied by U.S. firms and 18 percent by Singaporean firms. Most occupants are from multinational companies headquartered in Europe (51 percent), Asia (22 percent), and North America (20 percent). Occupants include law, information technology, commodities, energy, and insurance firms as well as financial service firms.

Flexibility is an advantage for developers and corporate occupants. Development sites that are zoned white are granted high development flexibility. Developers in these zones have the autonomy to develop property for a variety of uses and to respond to changing market needs.

With a prime waterfront location, high-end specifications, and larger floor plates (the amount of rentable floor space on one floor), buildings in Marina Bay have contributed to an increase in the average market rent. Of the six office towers totaling 510,000 square meters completed between 2006 and 2012, the average pre-let commitment level upon completion was 82 percent; four of the six towers were essentially 100 percent pre-let upon completion (CBRE 2012). In 2012 more than $18 billion was invested in the development. Marina Bay looks to be one of the most lucrative investments ever in Singapore, according to CBRE.

Lessons learned
The success of the new development is based on a positive feedback loop of high node value, high place value (created by the futuristic landscaping of Gardens by

PHOTO 4.14 “Supertrees” in Singapore’s Garden by the Bay

Source: © Serge Salat. Used with the permission of Serge Salat. Further permission required for reuse.
the Bay), and high market potential value. The project is a public-private partnership in which the state makes infrastructure investments and releases development sites to the private sector. Urban designs and planning objectives are articulated and achieved through conditions imposed on these sites. The fact that the Urban Redevelopment Authority is both the master planner and the place manager ensures that a central governing body is able to coordinate the infrastructural developments from concept to operation (CBRE 2012).

Notes

1 Urban fabric is the physical aspect of urbanism, emphasizing building types, thoroughfares, open space, frontages, and streetscapes.

2 This part of the chapter is based on information from Singapore’s Urban Redevelopment Agency.

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Bo01, the City of Malmö, and Developers’ Representatives. 1999. Quality Programme: Bo01 City of Tomorrow.


This case study describes the redevelopment of Hudson Yards, part of a comprehensive strategy to develop Manhattan’s West Side (image 5.1) and to maintain a high level of agglomeration economy in Midtown Manhattan. It analyzes the project using the 3V Framework, examining its node, place, and market potential values and describing the approach taken to capture some of the resulting increases in value.

A report released by Related Companies and the Oxford Properties Group (the project’s developers) outlines the substantial economic impacts of the 11.3-hectare Hudson Yards development on New York City’s economy (Appleseed 2016). The development will help modernize New York’s commercial office space, improve its global competitiveness, create jobs, and make major contributions to New York’s GDP and city taxes (box 5.1).

The Need for More Office Space in New York City

During the 1990s, New York City’s economy soared. Projections made in 2001 indicated that the city could add nearly 600,000 jobs by 2020—but that it would need more office space to do so. The projections indicated that these jobs would increasingly come from companies in the “ideas economy,” where value is created by “thinking things rather than moving things” (Group of 35 2001).

To accommodate the growth in the office sector, the city estimated that it would need about 6 million square meters of new office space by 2020. Without this new
space, New York stood to lose thousands of jobs and the economic activity they would generate. The shift of such jobs to New Jersey and Long Island would have implications for New York and the region, with a reduction in agglomeration economies that could be generated in highly concentrated jobs areas in Manhattan.
Case Study: Hudson Yards in New York City

IMAGE 5.1 Hudson Yards, Viewed from the Hudson River


BOX 5.1 Expected Impacts of Hudson Yards

More than 64 percent of the City’s office space is currently in buildings that are at least 50 years old. The development of Hudson Yards is one of New York’s most important responses to the demand for new office space to keep New York competitive with other global markets. Hudson Yards will bring 1 million rentable square meters of new office space—an amount greater than the total supply of office space in downtown Austin, Texas or downtown San Diego, California—into New York City’s marketplace.

Hudson Yards development, once fully operational, will contribute nearly $19 billion (all figures are in 2018 dollars annually to New York City’s gross domestic product, accounting for 2.5 percent of the city’s GDP. Upon completion, the project will produce nearly $500 million in annual taxes for New York City.

Companies and buildings at Hudson Yards will bring more than 55,000 jobs to the new West Side neighborhood. Related and Oxford’s Hudson Yards development is just one piece of the broader Hudson Yards district, which can accommodate 4.6 million square meters of development, including new park land; office, hotel, and retail space; and 20,000 apartments, including more than 5,000 affordable units. During the estimated 13-year construction period, Hudson Yards will create 7,030 full-time jobs each year, paying about $761 million in wages. Hudson Yards has been a major contributor to the recovery of New York City’s construction industry, with the early years of the project (2011–14) accounting for approximately 16 percent of the total increase in construction industry employment.

No project in New York City’s history has contributed as much as Hudson Yards to the Metropolitan Transit Authority (MTA), which received $1.784 billion in revenues from the project during its development and construction. Upon completion, Hudson Yards is expected to contribute $89.3 million annually to the MTA.

Source: Appleseed 2016.
The effects—including the loss of jobs and competitiveness; a reduction in tax revenues generated by Manhattan office space, a major contributor to New York’s operating budget; and the environmental costs associated with changes in the patterns of commuting, with an increase in the car share—were highly undesirable.

Office floor area ratios (FARs) in New York are highly variable, with values ranging from less than 0.25 to more than 30 (map 5.1). About 60 percent of New York’s office space is concentrated on 1 percent of the city’s land area (9 square kilometers, out of a total of 780). The concentration of residents is lower than the concentration of jobs (map 5.2). Mathematically, the distribution of office FAR values across the urban space follows an inverse power law, with a very steep gradient of $-1.7$ (see appendix A).

Midtown and Downtown are New York’s economic engines. The Midtown office market comprises 27.4 million square meters (44 percent of all office space in New York City). Combined with Downtown, this market totals 36 million square meters (59 percent of the total of New York City’s office inventory).

The central business district (CBD) in Manhattan offered opportunities for new office space through rezoning, but there was not enough space to meet projected demand. Potential development sites are insufficient to meet future demand of 4.2 million square meters in Midtown by 2025.

To meet those needs, the Group of 35 (a group organized by a U.S. Senator and including major developers, landowners, and business officials) called for the cre-
Case Study: Hudson Yards in New York City

formation of three new and expanded CBDs: the Far West Side of Manhattan, Downtown Brooklyn, and Long Island City. An extended IRT Flushing Line would serve the new CBD on Manhattan’s Far West Side, connecting the area to the Port Authority Bus Terminal, Times Square, and Grand Central Terminal. Development in the area was planned to provide at least 2 million square meters of office space.

For each location, the core strategy was to create an “urban business campus” as a catalyst for development. As private sector efforts alone were considered insufficient to produce the urban space needed for new economic growth, the strategy for each new CBD included the initiation of an urban business campus by the public sector. This strategy aimed at avoiding the initial reluctance of the private sector to consider locating in a new CBD because of the dearth of ready-to-go development sites, amenities, and business support services.

To jump-start the development process, the public sector (the City of New York and the State of New York) planned three urban business campuses, one for each new CBD. They included the following elements: 300,000–500,000 square meters of state-of-the-art office facilities; a park-like setting, with open spaces and pedestrian-friendly streetscapes; and amenities such as retail and dining establishments, business services, hotels, and entertainment venues and access to local cultural and academic resources.

The City and the State partnered to accomplish a number of tasks. They identified several blocks in the new CBD where the campuses should be located. They then assembled development sites by condemnation (appropriating property for public use), making financial contributions when necessary. They designated locations with the appropriate high-density commercial use zoning. They then solicited developers to build 300,000–500,000 square meters of new office space. Finally, they aggressively marketed projects and offered financial incentives to attract businesses to new developments.

MAP 5.2 Residential and Office Density in Manhattan

a. Residential densities

b. Office densities

Urban business campuses such as the one planned for Hudson Yards are expected to create a sense of place in the CBD and serve as a catalyst for ongoing private sector development efforts that will follow in adjacent areas. Some of the public sector investments will be recouped when sites are sold to private developers.

The Selection of Highly Accessible Sites for New Development

Over the centuries, New York has been able to make major public investments that trigger private market response. The grid plan of 1811 laid out the future of development for island of Manhattan at a time when few people thought development would expand north of Houston Street. Part of the success of New York is based on its ability to make strategic public investments that yield high returns long into the future.

The three areas identified by the Group of 35 Report as the future new CBDs of New York—the Far West Side, Downtown Brooklyn, and Long Island City—illustrate the strong connection between how accessible places are and how densely populated, used, and built up they are (box 5.1). They benefit or will benefit from high accessibility in 30 minutes by transit by New York City residents. Some 2.8 million jobs are accessible in less than a 30-minute public transit ride from Brooklyn Heights. The Far West Side will be better connected to Midtown Manhattan by extending the No. 7 Subway to reach the same levels of accessibility as the other locations.

BOX 5.2 Concentration of Transit Accessibility in New York City

Transit accessibility in New York City is highly concentrated in specific areas, creating a highly efficient urban form for agglomeration economies. In a 780-square-kilometer city with 8.5 million people, 4 million jobs are located less than half a mile from a mass transit station. The high concentration of jobs in Manhattan and the dense provision of subway infrastructure in New York City have created a highly efficient urban form with an integrated labor market: 1.35 million jobs are accessible within a 30-minute transit commute including walking time (box map 5.1.1), and employers have access to 700,000 workers within a 30-minute transit commute (box map 5.1.2).

In Manhattan an average 2.6 million jobs are accessible in less than a 30-minute public transit commute (excluding walking time), and more than 75 percent of commuters use transit; more than 1 million workers are accessible within a 30-minute transit commute to an employer. The highest concentration of accessibility is in Midtown, which is undergoing rezoning at higher density: 3.3 million jobs are accessible in less than a 30-minute transit commute, and 1.6 million workers are accessible within a 30-minute transit commute on average. In comparison, in Chicago (a city of 2.7 million people), 535,000 jobs are accessible within a 30-minute transit trip and 28 percent of commuters use transit; in Los Angeles (a city of 4 million people), 567,000 jobs are accessible within a 30-minute transit trip and less than 12 percent of commuters use transit (Center for Transit Oriented Development n.d.).

(continued on next page)
BOX 5.2 Concentration of Transit Accessibility in New York City (continued)

BOX MAP 5.1.1 Number of Jobs Accessible from Any Location in New York in Less than 30 Minutes Door to Door by Transit, Including Walking Time, 2015


BOX MAP 5.1.2 Number of People in New York Who Can Access a Given Location in Less than 30 Minutes Door to Door by Transit, Including Walking Time, 2015

Selection of the three areas corresponds to the peaks of closeness centrality (the most accessible parts in the network [see chapter 2]) (map 5.3). Hudson Yards and Downtown Brooklyn are adjacent to or peaks of betweenness centrality as well. The three new CBD locations have high node value, much of which is underutilized. The strategy of the Group of 35 was to enhance their place value to boost their market potential value.

**The Hudson Yards Project**

Proximity to the Midtown CBD, accessibility to the regional workforce, and a vast amount of vacant and underdeveloped land make Manhattan’s Far West Side an ideal location for development. The Hudson Yards Project is a master-planned development that seeks to transform the area into a thriving business district with a mix of residential, commercial, and recreational spaces.

MAP 5.3 Degree, Closeness, and Betweenness Centralities of Subway Stations in New York

a. Degree centrality

b. Closeness centrality

c. Betweenness centrality

ideal location for creating a new CBD. As the Hudson Yards Master Plan Preferred Direction notes:

The planning for Hudson Yards anticipates a multi-decade-long time horizon for the redevelopment of the Hudson Yards (photos 5.2 and 5.3). This area is one of the great opportunities to secure the City’s economic future in the global market place. It is anticipated that through decisive public sector actions, such as the expansion of mass transit, creation of character-defining open space, and reinvention of the area’s zoning, these actions would spur the private investment that will sustain the livelihood of future generations of New Yorkers.

The Hudson Yards Redevelopment Project is a joint venture by New York City and New York State run by the Metropolitan Transportation Authority (MTA) to encourage development on Manhattan’s Far West Side along the Hudson River. The project in-

**PHOTO 5.2 Aerial View of the Hudson Railyards (West and East Yards)**


**PHOTO 5.3 Hudson Yards Worksite**

Transforming the Urban Space

Inclues rezoning of the Far West Side into a new high-density mixed-use neighborhood; extension of the No. 7 Subway; creation of new open space; and renovation of the Jacob K. Javits Convention Center. The centerpiece of the project is the development of a 11.3-hectare mixed-use real estate development by Related Companies and Oxford Properties over the John D. Cammermayer railyards (where the commuter trains that serve Long Island stay when they are not in service), split into Eastern and Western Yards. The original design of the yards foresaw the construction of a deck on top of them when market demand warrants it.

To complete the 28-acre Hudson Yards development, two platforms must be constructed to bridge 30 active Long Island Rail Road train tracks. Two subsurface rail tunnels will be used by Amtrak and New Jersey Transit. A tunnel box was constructed on the Manhattan side of the river to preserve the possibility of constructing a future trans-Hudson under river crossing. The foundations of the finished buildings extend through and rise above the platform. The platforms will cover approximately three-quarters of Eastern and Western Yards. Throughout construction, the Long Island Rail Road, Amtrak, and New Jersey Transit trains will remain operational.

The Eastern and Western Railyards will be a neighborhood with 1.6 million square meters of floor space. Half of the developed area will be open space. It is the largest private real estate development in the history of the United States and the largest development in New York City since Rockefeller Center was built, in 1939. It is expected that additional public investment in parks, mass transit, and infrastructure will turn it into one of the most livable areas of the city.

There is a precedent to the Hudson Yards project: Park Avenue. Responding to public outrage at the pollution and filth of the New York Central Railroad railyards in mid-Manhattan, in 1903 the state legislature passed a law requiring the railroad to “cover its tracks.” In response, the railroad built a deck over the newly electrified tracks from Madison Avenue to Lexington Avenue, between E. 42nd and E. 56th streets. Down the middle of the deck a grand boulevard was built. It was crowned with a magnificent new train station, Grand Central Terminal. Over the next three decades, new hotels, office buildings, and apartments sprang up along Park Avenue, forming the core of what would become the world’s greatest central business district. One hundred years later, the trains still run under Park Avenue, and 160,000 people earn their living in the blocks over the tracks (NYC Planning n.d).

Increasing Node Value

Public transit networks—their structure and how they connect people to people—completely change how people perceive distance and how businesses and jobs are located. Strategically located between 10th and 12th Avenues between W. 30th and W. 34th Streets, Hudson Yards is near the center of the metropolitan region.

The center of the metropolitan region offers connections to commuter rail service, the subway system, the West Side Highway, the Lincoln Tunnel, and ferries along the Hudson River. Penn Station, located nearby, is the busiest transportation facility in the United States, handling more than 600,000 New Jersey Transit, Long Island Railroad, and Amtrak passengers daily in 2015. The Port Authority Bus Terminal is the busiest such terminal in the United States, serving 200,000 passengers a day with 7,200 buses in 2015. Buses link the area to the region’s three major
airports. Commuters from parts of New York and New Jersey can reach the Far West Side via ferry, with expansion plans allowing for trans-Hudson service for up to 60,000 passenger trips a day. Vehicular travelers can reach the Far West side via the Lincoln Tunnel (map 5.4).

Despite its location, Hudson Yards lacked direct mass transit connectivity west of Eighth Avenue. The development strategy entails critical infrastructure improve-

**MAP 5.4 Access to Hudson Yards**

a. Regional access map

b. Hudson Yards transit access map

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ments to address this issue. These improvements include extending the No. 7 Subway to connect to the Port Authority Bus Terminal, and Grand Central Station; bringing Metro-North to Penn Station; mitigating traffic around the Lincoln Tunnel; and building a platform above the railyards for real estate development and pedestrian flows. The No. 7 Subway Extension west and south of its current terminus at Times Square, a $2.4 billion investment, added a new station at W. 34th Street and 11th Avenue (image 5.2).

Increasing Place Value

Numerous amenities near Hudson Yards—including Madison Square Garden, the Javits Center, and the Broadway theater district—already attract millions of visitors. The strategy for the development builds on these amenities, as well as the proximity of three parks.

Three dynamic parks and the High Line effect

Creating place value in Hudson Yards is based primarily on the design of public space. Half of the site is set aside for public open space (image 5.3).

The site connects directly with the High Line, an elevated park that quickly became the second most visited tourist attraction in New York, a dynamo for high-end real estate development, and an iconic architectural project (photo 5.4 and images 5.4–5.6). A revolutionary public space and urban revitalization project, the High Line is a plant-lined elevated parkway converted from a long-abandoned freight line snaking above the West Side of Manhattan. Designed by Diller Scofidio + Renfro, the 2.4-kilometer parkway, which sits 9 meters above street level, wraps

IMAGE 5.2  The New No. 7 Subway Station at W. 34th Street and 11th Avenue

around Hudson Yards as it curves toward the Hudson River, revealing sweeping waterfront views at its northern end. The High Line combines elements of the original railway with native flora and fauna. The characteristics of former tracks—flat, long, frequently running through historical areas—are appealing for various developments. New growth on the West Side can be attributed to the success of the High Line, which has spurred $2 billion of private investment, 12,000 new jobs, and 29 development projects since opening in June 2009.

The site will become one of the greenest neighborhood in the city (images 5.7 and 5.8). It connects to Hudson River Park, a five-mile long waterfront park that will
provide open space, waterfront access, and walking and bicycle pathways. It is organized around the new Hudson Park and Boulevard Public Park (built at a cost of $30 million), creating a network of open space. The development also has easy access to a six-story building to host cultural activities (the Culture Shed) and a large public square (map 5.5).
Mixed-use development

By 2024, when the project is completed, 125,000 people a day will work in, visit, or live in Hudson Yards. The neighborhood will include more than 1.6 million square meters of commercial and residential space, 5 state-of-the-art office towers, about 5,000 residences, a 750-seat public school, a unique cultural space, 5.6 hectares of public open space, a 175-room luxury hotel, restaurants, and more than 100 stores (image 5.9).

Smart city systems that make development connected, reliable, efficient, and responsive

Related Companies designed the area to be ready for the future: Communications will be supported by a fiber loop, designed to optimize data speed and service continuity for rooftop communications, as well as mobile, cellular, and two-way radio communications. This will allow continuous access via wired and wireless
**MAP 5.5** Open Space at Hudson Yards


**IMAGE 5.7** Hudson Yards Looking West

broadband performance from any device at any on-site location. Whatever the disruption, Hudson Yards will have the onsite power-generation capacity to keep basic building services, residences and restaurants running. Buildings at Hudson Yards are connected through a micro grid allowing them to be heated and cooled by their own equipment or that of their neighbor.
Social diversity
Local affordability was a major concern with earlier transferrable development right schemes in New York, since commercial densification had historically paid little attention to ensuring the interest of local communities, which would suffer from rising costs and increasingly unaffordable living options. In the context of Hudson Yards, social diversity has been emphasized as a principle, even if market-rate residential units at Hudson Yards are expected to sell for $20,000–$35,000 per square meter and the retail and commercial space will be expensive.

Flexibility and development bonuses are offered to developers for providing affordable housing. Some affordable rental apartments were allocated by lottery in 2016. More affordable units might be delivered later, but Related Companies focused first on commercial development. It leased all of its properties with high-end tenants.

Increasing Market Potential Value

Responding to market demand through a well-located underutilized area
The market potential value of a station area is assessed by identifying the unrealized market value around it and estimating market demand at the city level (see chapter 2). New York City, particularly Manhattan, has strong needs for new office space in well-connected areas. Manhattan is also one of the United States’ tightest housing markets, with an estimated vacancy rate of 2.87 percent in November 2015 (Carmiel 2015). People in New York City are clustered at high densities in the areas with the highest accessibility to jobs and to Manhattan in 30 minutes. According to census data, Manhattan gained about 100,000 residents between 2000 and 2014 (increasing its population from 1.54 million to 1.64 million). Demand for new housing is great and expected to grow.

The enhancements of node value and place value on the Far West Side will unleash the high market potential of the area. Increasing the connectivity of and creating jobs in Hudson Yards will be a catalyst for development of the entire Far West Side. The number of accessible jobs will increase significantly beyond the boundaries of the project itself, fostering increases in human densities (people + job densities) and land and real estate development.

The proximity to Midtown Manhattan is the most compelling market potential value asset of the Far West Side, since the area can be seen as a natural extension of this existing market, providing convenient access to clients and other business services in Midtown, and a tremendous advantage in terms of bridging the psychological barriers that affect firms’ locational choices. This untapped market potential value has been unleashed through rezoning of the area. Previous zoning was for low-density industrial uses. The maximum floor area ratio of 5 was not enough to encourage private investment in commercial development.

The Far West Side has adequate space to accommodate a large-scale office district. It is a remarkably underdeveloped area of Manhattan, with 128 unbuilt lots and 27 hectares of vacant development space. After rezoning, the area can easily accommodate at least 2 million square meters of new office development, as well as other commercial, residential, and retail uses.

When preparing the Master Plan for Hudson Yards, New York City identified the vision and driving direction for the development of the overall area (the Preferred
Direction 2003), including zoning for appropriate densities and uses. This Preferred Direction directs the highest density to the areas that will most benefit from subway access—namely, the regional 42nd and 34th streets and across from the Javits Convention Center. The rezoning strategy seeks to preserve the Ninth Avenue scale by keeping the density near existing levels. The Ninth Avenue is separated from the higher density areas by a band of moderate density areas (maps 5.6 and 5.7). In 2009 the West Side Yard was rezoned.

**MAP 5.6 Hudson Yards Land Use Plan**

![Hudson Yards Land Use Plan](source)


**MAP 5.7 Hudson Yards Master Plan, 2016**

![Hudson Yards Master Plan, 2016](source)

Flexible zoning and tax abatement
Adapted zoning in Hudson Yards sets varied FARs for predominantly commercial, mixed-use, and predominantly residential in order to introduce flexibility and capture value. Developers of commercial or residential projects in the Hudson Yards area have an opportunity to receive a zoning bonus that would allow their project to exceed the base maximum FAR (or "as-of-right") established in the zoning resolution by making a District Improvement Bonus (DIB) payment to the Hudson Yards District Improvement Fund (about $1,350 per square meter), through transfer of development rights, or through provision of inclusionary housing (image 5.10). The inclusionary housing bonus for specific parts of the development allows 10–15 percent of the development to be affordable to low-, moderate-, or middle-income families (maps 5.8 and 5.9 and image 5.11). The New York City Industrial Development Agency’s (NYCIDA) Uniform Tax Exemption Policy (UTEP) also includes financial incentives, including real estate tax discounts, for commercial development projects in the Hudson Yards area (map 5.10).  

Financing structure for public spaces and connecting infrastructures
The cost of phase 1 infrastructure was initially estimated at $1.763 billion for the No. 7 Subway Extension, $351 million for Eastern Railyard platform, and $361 million for open space and streets (HYIC 2004). Cost estimates for phase 2 were $250 million for the No. 7 Subway 41st Street Station and $271 million for the midblock boulevard and parks. The total cost of public spaces for the 2 phases was estimated at $632 million. Total infrastructure costs for the 2 phases with the subway

**IMAGE 5.10 Options to Increase Floor Area Rations Against Contributions**

Source: Image used with permission of the New York City Department of City Planning. All rights reserved.
Case Study: Hudson Yards in New York City

**IMAGE 5.11** Affordable Housing Percentage Against Additional Floor Area Ratio

![Diagram showing FAR and percent of affordable units required](image)

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**MAP 5.8** Inclusionary Housing Area at Hudson Yards

![Map showing inclusionary housing areas](image)

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Transforming the Urban Space

The Hudson Yards Investment Corporation (HYIC), a local development corporation, was created in 2005 under the Not-for-Profit Corporation Law of the State of New York to finance certain property acquisition and infrastructure development, including the No. 7 Subway Extension. The Hudson Yards Development Corporation (HYDC) is a local development corporation created by the city to manage and implement the project. The two corporations have separate financial statements.

HYIC collects revenues, including payments in lieu of taxes (PILOT) and district improvement bonuses from private developers and appropriation from the city; pays principal and interest on its bonds; and disburses bond proceeds to pay project costs. Its revenue streams include interest support payments by the city; PILOT; tax equivalent payments for property taxes on new residential development in the project area; district improvement bonuses against additional density; and payments in lieu of mortgage recording (PILOMRT). Under the support and development agreement between HYIC, HYDC, and the City, the City agreed to make payments, subject to annual appropriation, in an amount sufficient, together with HYIC other revenues, to pay interest on outstanding bonds (HYIC 2015).

HYIC acquired a 50 percent interest in the Eastern Railyards Transferable Development Rights (TDR), allowing developers to build larger buildings than otherwise permissible under zoning law. The proceeds received by HYIC for the sale of the

MAP 5.9 Uniform Tax Exemption Policy (UTEP) for Hudson Yards

Source: © Hudson Yards Development Corporation. Used with the permission of Hudson Yards Development Corporation. Further permission required for reuse.
TDRs up to the amount of HYIC’s investment (including total purchase price and interest costs) will be used to support its operations and service its debt.

By the end of 2006, $3 billion of Hudson Yards bonds had been sold, making the project fully financed. Of this amount, $1 billion were sold in October 2011. They were rated A by S&P and Fitch, and A2 by Moody’s. Another $2 billion of bonds were sold in December 2006, with similar ratings.

In 2008 the commercial real estate market crashed. The MTA started negotiations with selected developers before the crash (Related was not the first team selected; originally Tishman was selected). The real estate crash delayed the project, because developers were unable to secure financing. Eventually the City Council had to vote to pay for a few more years of debt service payments.

New development will generate various streams of revenue that are expected to cover these costs over time. It is expected that these streams of revenue will largely cover the debt service and that the project will generate cumulated incremental revenues to City and State of $67 billion between 2005 and 2035 (figure 5.1).

**Notes**

1 The chapter is based on public information and information from Related Companies and Oxford Properties, the developer of Hudson Yards.

2 The report, prepared by Appleseed, a New York City-based consulting firm that provides economic research and analysis and economic development planning services to government, non-profit and corporate clients, finds that Hudson Yards will be a significant contributor to New York City and Metropolitan Transportation Authority (MTA) revenues, both during and after construction.
Transforming the Urban Space

A report on Paris documents the correlation between the number of people who can access a given location and the density of companies. It shows the impact of transit accessibility on firms’ locational choices (Salat and Bourdic 2015). A report on London shows a similar correlation between the number of people who can access a borough in 45 minutes by transit and the employment density in the borough (GLA 2004).

To learn more about this program, refer to the complete NYCIDA Uniform Tax Exemption Policy (see appendix F for the Hudson Yards incentives).

References


This case study shows how the dynamic power of imbalances between node and place values can trigger massive regeneration of a former industrial area, creating a major new economic node. King’s Cross is a mixed-use, urban regeneration project (map 6.1) in Central London and a major transport hub. The site is an interchange station with six London metro lines, two national train stations (King’s Cross and St Pancras [photo 6.1]), and an international high-speed rail line (HS1) connecting to Paris, making it the most connective hub in Central London. Investment in high-quality public space and local pedestrian connectivity and mixed-use development triggered a strong market response, raising market potential.

In 1996 strategic planning guidance for London identified King’s Cross as one of five “central area margin key opportunities.” It called for mixed-use development, with an intensification of densities and commercial uses close to the station, as well as urban regeneration and support to local communities, including a housing program (some of it affordable housing) and community facilities. Planners also called for maintaining and enhancing features of historic and conservation importance to create a neighborhood with a distinct character, identity, and image.

The area of opportunity for urban regeneration spanned over 27 hectares of fragmented land and old industrial buildings located on the site of former rail and industrial facilities to the north of the transport hub and in front of the two rail stations (photo 6.2). Redevelopment has involved restoration of historic buildings and new construction. The site has been regenerated and made attractive by provision of ample public spaces. The plan increases local connectivity, accessibility, and permeability, with a dense pattern of internal streets. It creates high place value,
MAP 6.1 King’s Cross Master Plan

Source: © King’s Cross Central Limited Partnership. Used with the permission of King’s Cross Central Limited Partnership. Further permission required for reuse.
with 10.5 hectares of open space, 316,000 square meters of office space, almost
2,000 residential units (42 percent of which are affordable housing), 46,400 square
meters of retail and leisure space, a hotel, and educational facilities.

This chapter provides an overview of King’s Cross, based on the 3V Framework.
It reviews the node, place, and market potential values of the area and the ap-
proach taken to capture some of the resulting increase in value.
Increasing Node Value

King’s Cross Station, in the core of London, is a major interchange station at the scale of the city, the United Kingdom, and Europe (map 6.2). It has one of the highest node values in Europe, with very high levels of connectivity and accessibility. Five international airports are within an hour, including three with direct connections to King’s Cross. King’s Cross is also the biggest inner-city transit interchange in London, linking 6 metro lines and 17 bus routes.

King’s Cross—together with the St Pancras and Euston stations—is expected to function as the principal transit center for London. The 2004 London Plan expected that with the completion of the Channel Tunnel Rail Link-High-Speed 1 (HS1), the Thameslink 2000, and the Cross River Tram, King’s Cross will become the most accessible station in Greater London. The decision in 1996 to move Britain’s first high-speed railway, the Channel Tunnel Rail Link, from London Waterloo Rail Station to St Pancras provided the catalyst for landowners LCR and Exel (now DHL) to develop the King’s Cross site.

The Western Concourse between King’s Cross and St Pancras stations is designed as a public plaza with legibility, linkage, and transparency (photo 6.3). Like the British Museum’s Great Court (photo 4.4), the space acts as an internalized exterior, where the sky is materialized by an impressive architectural structure and the façade acts as a wall.

Increasing Place Value

After the King’s Cross site became an integral part of HS1 development in the late 1990s, plans to redevelop the site became a real possibility. Lack of market appetite
Creating High Node and Place Values: King’s Cross in London

had postponed such plans multiple times in earlier decades. To the north of the two train stations lay 27 hectares of former rail and industrial facilities. There was thus a strong imbalance between very high connectivity about to emerge and low intensity of land use. This imbalance opened an opportunity to increase place value by redefining, reshaping, and creating value on former rail land to the north of the two stations and transforming King’s Cross Square in front of the stations (photo 6.4).

King’s Cross is a unique development from a planning perspective. It took almost six years to design, negotiate, and receive planning consent. Four rounds of public consultations were held, involving some 30,000 people. The developer and government listened and adapted the scheme based on feedback.
**Keeping the Master Plan Flexible**

Two master planning teams and four independent design review panels led to a highly tailored scheme that responded to the needs of multiple stakeholders. Planning balanced the developer’s long-term aspirations to create and manage a long-term asset and the local authority’s desire to integrate it into the deprived communities that surrounded the area through urban regeneration. The developer started from a blank piece of paper, built the scheme based on principles and precedents, and realized its vision in the master plan (see map 6.1).

The master plan unifies the site with a comprehensive vision, but it is flexible enough to accommodate change. This flexibility will enable King's Cross to adapt to changes in social and technological trends. Development is not functionally locked into the needs and technologies of today but has been left enough margin to evolve with needs and market shifts. Changes in the proportions of uses and transformation of buildings to respond to changes in market conditions have been integrated in a planning conceived more as a continuing process than as a once and for all exercise.

To balance this adaptability and maintain continuity, order in space, and identity, key physical aspects of the site were fixed. Streets and public spaces, the most resilient features of neighborhoods, were defined. To create visual order in space and avoid out-of-proportion construction that would obstruct views and the flow of well-defined public space, maximum and minimum building heights were fixed in various zones. These standards ensure consistency in density and scale throughout the site. To provide a sense of unity, uniqueness, and harmony while allowing for diversity and variety, design guidelines describing building techniques, materials, and how materials can be used were also established.

Planners have been careful not to be too prescriptive about the tone, character, and feel of the area. Instead, specific details of the new district have been allowed to emerge over time, aided by a master plan that allows room for flexibility, negotiation, change, and experimentation with occupiers and activities (ULI 2014).

**Attracting High-Tech Companies**

The high-quality development attracted Google, which spent about £650 million to buy and develop a 1-hectare site on a 999-year lease from King's Cross Central Limited Partnership, the partnership developing the site. The finished development (93,000 square meters) will be worth up to £1 billion. Several thousand staff will occupy the low-rise structure. Google’s U.K. headquarters will be its largest office outside its corporate headquarters in California. The building includes 4,650 square meters of ground-floor retail. Google’s presence is expected to draw other technology companies, especially small start-ups, and help bump up rents.

**Combining High Density with Medium-Size Buildings**

High density at Kings Cross is achieved not through high-rises but through 50 medium-size buildings designed at human scale. The high density, mixed-use, infill redevelopment with an average floor area ratio (FAR) of 4.6 at block scale com-
Creating High Node and Place Values: King’s Cross in London

PHOTO 6.5 Blending of Heritage and Modernity at King’s Cross

bines heritage and new buildings (map 6.3). Twenty heritage buildings are being retained and refurbished as shops and restaurants. Their color and character reflect the unique nature of the development, which blends historic and contemporary architecture (photo 6.5).

Reshaping the Image of King’s Cross

Image exerts a powerful influence over site development. The density of accessible local amenities, cultural and leisure assets, and green spaces increases place value. Developing a mix of land uses contributes to a location’s success and reduces the developer’s risks. Mixed-use schemes are more adaptive to market changes if enough flexibility is allowed to shift uses. Such schemes allow developments to quickly establish themselves within an emerging urban neighborhood with an appealing sense of place.

According to the King’s Cross Public Realm Strategy: The area in and around King’s Cross has been in constant evolution and is marked by its history as one of the first “intermodal” hubs in the United Kingdom, with connected water, rail and road modes of transport. Its character reflects directly its history, forming one of the most significant groupings of early Victorian buildings in London. These existing buildings and structures have been very influential in the layout of uses across the site.

One-quarter of King’s Cross is dedicated to cultural and leisure uses. The historic fabric was embedded in the plan in a sophisticated manner, rather than merely preserved. Every building has a new use and a relationship to its neighbors and the spaces in between (photos 6.6 and 6.7).
Transforming the Urban Space

The tranquility of the canal and the views to the Camley Street Natural Park offer a contrast with the new shops and cafes in the Coal Drops (a former coal transfer point between rail and wagons and road carts) and Granary Square. A new pedestrian bridge across Regent’s Canal and other links have been created to “capitalize upon the canal’s positive contribution to King’s Cross and to bring life to the canal, enhance its character, wildlife value and recreational use and improve access and safety” (Argent 2002).

Creating High-Quality Public Space

The public realm is a physical and social entity that comprises the spaces between buildings and the activities happening in them. It is at the heart of the King’s Cross concept:

[Public realm] means an arrangement of routes and public spaces—be it traditional streets and squares or other links and connections—to and through the surrounding city. Establishing the right framework is very im-

MAP 6.3 Mixed-Use Development at King’s Cross

Source: Argent 2014b © King’s Cross Central Limited Partnership. Used with the permission of King’s Cross Central Limited Partnership. Further permission required for reuse.
PHOTO 6.6 Children Playing at Granary Square, the Canal Side Heart of King’s Cross

Source: © Françoise Labbé. Used with the permission of Françoise Labbé. Further permission required for reuse.

PHOTO 6.7 Regent’s Canal, an Integral Part of the King’s Cross Development

Source: © Françoise Labbé. Used with the permission of Françoise Labbé. Further permission required for reuse.
Transforming the Urban Space

The design aims at achieving an attractive and legible public realm—“a busy, thriving and exciting destination; a confluence of people and activity; an outstanding place to live, work, or just be” (EDAW and others 2004).

King’s Cross Central is built around the social, functional, and symbolic importance of the public realm in providing spaces for people to meet and spend active and leisure time. The public realm is high grade, but it is not just corporate design to create high-priced rentals. It is also meant to be a part of London—open, democratic, and accessible.

In total, some £2 billion will be invested in local transport infrastructure and the public realm, including £250 million for 20 new streets, 10 new public spaces, and 5 major squares totaling 3.2 hectares. The planning team “spent a lot of time thinking about the spaces in between buildings, about how people would use those spaces” (ULI 2014). Some 40 percent of the development will be devoted to open space (figure 6.1). Some of the built space will also include public spaces, such as courtyards and gardens.

The design of King’s Cross connects people to people with a continuum of outdoor areas and in some cases large indoor areas, such as the west concourse at the King’s Cross Station. It encompasses streets, parks, squares, pedestrian areas, canal promenades, cycle paths, and trails as a continuum of interconnected spaces that can support a wide variety of activities. A goal is to generate pedestrian movement and activity.

King’s Cross illustrates how both high-quality design and long-term management strategies help create a good public realm. The continuous flow of spaces,
Creating High Node and Place Values: King’s Cross in London

Routes, and views and the vibrancy of interactions within the public realm is supported by high-quality detailing that creates a rich and constantly changing information and activity field for pedestrians. Special attention to paving, planting, orientation, light and shadow, shelter, signage, and street furniture makes spaces accessible, safe, and legible (photo 6.8).
Ensuring Unrestricted Use of the Public Realm

According to the King’s Cross Central Public Realm Strategy (EDAW and others 2004):

The traditional heart of civic life is centered on the town-square, the high-street and town-park, elements of the public realm, around which community life revolves and civic pride is focused. Civic space traditionally suggested a mode of behavior reflecting either the importance or use of the space, or the civic function of the day. Hence a town-square may be a market place one day and a place of remembrance on the next.

Argent, the developer, sought to achieve this civic meaning of the public realm by following other London examples of unrestricted use of the public realm that is owned and managed privately balancing access and quality, and managing the space with the public in focus.

Clear definition between the public realm and the private domain is provided at King’s Cross with built form rather than walls, fences, or planting. Where it was desirable to limit access or use to residents or employees, features such as rumble strips, different road surface (by color or texture), pillars, and narrower carriageway were used to delimit the private space and give the impression that the area beyond is less public and more private.

Creating Active Streets

The King’s Cross design creates active streets with retail stores, bars, cafes, and restaurants to keep the neighborhood lively throughout the day. All ground-floor units are, or will be, leased to these types of occupants. But the approach goes beyond individual streets within King’s Cross Central. It creates a network of safe pedestrian routes that connect key sites in the development and closely connect the development with the surrounding communities in Camden and Islington (map 6.4).

The site design includes a variety of promenades for various time of day and types of people, each with a different emphasis or theme (as represented by the colors on the site map [map 6.5]). These trails integrate places for people to walk or linger. Tiered stone seating and steps cascade from Granary Square to Regent’s Canal, enhancing the south-facing aspect and reinforcing the historic relationship between the canal and the Granary, the geographic heart and heritage soul of King’s Cross (photo 6.9).

To the west of the site is Camley Street Natural Park (photo 6.10). Created within a relatively small space, it expresses a unique fusion between Central London’s density, rich industrial archaeology, green space, and nature conservation. The focal point is a floating platform that brings architecture and nature closer together, allowing people to take in unrivalled views of both Regent’s Canal and the Camley Street Natural Park. Inspired by the rocky islands off the Nordic coastline, the platform is an important new learning facility for the park.
Increasing Market Potential Value

Flexible use and a clear focus on fostering market value, have enabled value capture as shown in this section drawing on Suzuki and others (2015).

**Ensuring Flexible Uses to Adapt to Market Conditions**

The agreement for the redevelopment of King’s Cross set floor space maximums stimulating diverse site use (table 6.1). The agreement allows for flexibility in land
PHOTO 6.9 Tiered Stone Seating and Steps Cascading from Granary Square to Regent’s Canal

PHOTO 6.10 Floating Platform at the Camley Street Natural Park at King’s Cross
uses to enable the developer to adapt to market conditions, as redevelopment is likely to take 10–15 years to complete. Use within the total floor space is allowed to vary by 20 percent; floor space allocated to one use can be traded against another, to a limited extent.

**Financing and Fostering Market Potential Value**

King’s Cross is funded through a combination of equity, debt, and recycled revenues. Cash flow management has enabled the partnership’s equity to be used across a variety of projects to create demand and interest from potential buyers. The total estimated value of the entire King’s Cross project, including construction, professional fees, and interest, is expected to reach £3 billion (ULI 2014).

The partnership has made £250 million of investments in public realm infrastructure since 2009, unlocking 557,000 square meters of development. Equity funding went toward creation of the public realm, including new roads (including King’s Boulevard), new public spaces (including Granary Square), a new bridge across Regent’s Canal, canal side improvements, and the Energy Centre and its district heating and distribution networks. The King’s Cross Central Limited Partnership also signed a £100 million construction contract with the University of the Arts, which will build a campus at King’s Cross (ULI 2014).

About £300 million of debt secured since 2009 has been used to finance some of the direct construction costs of residential and office buildings. This debt package, from four leading banks, provided loans for three commercial buildings, the final phases of infrastructure, and 272 apartments. The U.K. Homes and Communities Agency provided £42 million in public funds to support affordable housing (ULI 2014).

After development, the new balance between high node value and high place value is expected to foster high market potential value, with rental and real estate performance exceeding that of London as a whole.

**Capturing Value**

One key land value capture technique adopted by local governments in England and Wales is of Section 106 of the Town and Country Planning Act of 1990. It

<table>
<thead>
<tr>
<th>Use</th>
<th>Floor space (sq. m.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed-use development—total permissible</td>
<td>739,690</td>
</tr>
<tr>
<td>Offices</td>
<td>Up to 455,510</td>
</tr>
<tr>
<td>Retail</td>
<td>Up to 45,925</td>
</tr>
<tr>
<td>Hotels/served apartments</td>
<td>Up to 47,225</td>
</tr>
<tr>
<td>D1 (nonresidential institutions)</td>
<td>Up to 74,830</td>
</tr>
<tr>
<td>D2 (assembly and leisure)</td>
<td>Up to 31,730</td>
</tr>
<tr>
<td>1,900 homes</td>
<td>Up to 194,575</td>
</tr>
</tbody>
</table>

Source: Suzuki and others 2015.
provides a means for local authorities to negotiate agreements or planning obligations with landowners or developers in return for the granting of planning permissions to offset the negative impact of development.

Section 106 agreements have been crucial in incorporating desirable planning principles into public-private funding and property development at King’s Cross. They underscore the importance of balancing interregional business marketability and local community livability with public-private partnership–based infrastructure funding and property development (Suzuki and others 2015).

Section 106 agreements include cash and in-kind contributions by the developer to the local authority (Camden Council) for local infrastructure, public space, and community services (figure 6.2). The package includes £2.1 million to create 24,000–27,000 local jobs through a construction training center and skills and recruitment center; 1,900 homes, more than 40 percent of which will be affordable housing; cash and in-kind contributions for community, sports, and leisure facilities; new green public spaces, new landscaped squares, and well-designed and accessible streets, which account for about 40 percent of the entire site; a new visitor center, education facilities, and a bridge across the canal to link streets; and cash contributions to improve adjacent streets, transit stops, and bus services (Camden Council 2006).

Under the supervision the Department for Transport, London & Continental Railways (LCR) has been mandated to maximize its long-term asset value. Its development strategy has been to use its major sites as equity to participate in joint-venture development companies that can make long-term profits through urban regeneration around HS1 stations (chiefly King’s Cross and Stratford). Opportunity areas were identified and regeneration proceeded after the local authority approved the plans in 2006, with an initial target completion date of 2016.
As part of the construction of the HS1 project by LCR, the Department for Transport provided financial assistance to the then private LCR to cover part of the construction costs, the project's debts, and the operations of LCR and its subsidiaries. LCR was also granted property development rights around the King's Cross and Stratford Stations. This arrangement was to continue until the concession contract expires in 2086, at which point the assets would return to the government. Based on the 1996 arrangement between the government and LCR, the Department for Transport expected to receive half of LCR's net profit after deducting the costs for the King's Cross development scheme (Suzuki and others 2015).

The developer (Argent) was selected as a private partner in 2001. It entered into a joint collective ownership acquisition and development agreement with the landowners, in a deal that included an agreement that the land be valued following the approval of planning permission and completion of HS1. Upon valuation, Argent would have the option to acquire the land from the landowner or enter into a 50/50 partnership with it. The price paid by Argent was to be discounted based on the land open market value, with the discount increasing as the value of the land rose.

The deal incentivized Argent to optimize the value of the scheme. Under the agreement, land value would be established once the landowners (LCR and DHL) provided vacant property (which they were to do after HS1 was completed and open) and the developer completed its planning, submitted a viable business plan, and secured funding. The agreement was designed to be concluded when certainty had been delivered by all parties. The London Borough of Camden granted planning permission for regeneration in 2006, and LCR, Argent, and DHL jointly formed the King's Cross Central Limited Partnership in 2008 (Suzuki and others 2015).

A long-term development partnership was created in which Argent owns a 50 percent interest, the government-owned LCR holds a 36.5 percent interest, and DHL Supply Chain (formerly Exel) holds a 13.5 percent stake. Argent brought the backing from a large pension fund (BTPS, managed by Hermes Investment Management), essential for the private development of the site.

In 2009 the Department for Transport took over LCR, which had accumulated too much public debt in the construction of HS1. Following the concessioning of HS1, LCR was restructured into a property development and management company in 2011. A central feature of LCR's current business profile is that returns from its property interests are expected to be mainly in the form of capital appreciation over the next 5–10 years.

By March 31, 2014, six years after the actual development had started, more than 57 percent of the redevelopment project by floor area had been either completed or committed. Redevelopment continued to proceed apace, and financial contributions to LCR began. In January 2015, LCR sold its stake in the project to an Australian pension fund for £371 million, according to the company's audited statements. DHL did the same. Increases in the profit contributions and investment carrying value arose predominantly from disposal and reevaluation of investment properties. LCR also lent funds to the King’s Cross Central Limited Partnership for regeneration.
References


Increasing Connectivity and Economic Value along a Transit Line: Crossrail in London

In 2009, the United Kingdom and London initiated construction of Crossrail, one of the largest rail infrastructure projects in Europe. The first part of the network (the Elizabeth Line) is scheduled to open in December 2018 (map 7.1).

The first part of the network (the Elizabeth Line) is scheduled to open in December 2018 (map 7.1). The new train line will deliver a much-needed increase in rail capacity—but it is much more than a new rail link. It is an infrastructure scheme that fully integrates regeneration and wider economic benefits into its business case and activities. By bringing an additional 1.5 million more people within a 45-minute transit ride from job clusters, Crossrail will increase inclusiveness and integrate more people into London job market. The project is expected to become a catalyst for urban regeneration in key locations and a driver of London’s economic growth. Crossrail has spurred urban regeneration across its network of 40 stations.

This case study shows how node and place values vary along the new line, triggering different market potential and responses. The most central station areas, where job concentration and connectivity is already extremely high, are the main beneficiaries of high market potential increases. Market opportunities are also possible in fringe areas, provided the right development strategies are put in place.

London’s Booming Population and Economy

London is the world’s leading center for international business and commerce and one of the “command centers” of the global economy. It has the fifth-largest city economy in the world (after Tokyo, New York, Los Angeles, and Seoul) (Parilla and
The city’s economy is roughly the size of Sweden. London is projected to be the world’s second most competitive city (after New York) in 2025 (Economist Intelligence Unit 2013).
London’s booming population is set to break the 9 million mark within the next decade. The London Plan 2016 projects that the city will add nearly 1.1 million people in working age and 900,000 new jobs by 2036. By 2050 the population could reach 13.2 million people, nearly twice its 1991 level, with 240,000 more daily travels into Central London by 2025. The projected 35 percent growth in public transit trips will put additional pressures on the transit network.

**The Importance of Crossrail to London’s Competitiveness and Growth**

Transit acts as an enabler of economic growth for London, shaping employment concentration and agglomeration economies. The quality of the city’s international connections and intracity network is a crucial component of its competitive advantage. London dominates rail travel in the United Kingdom: 62 percent of all rail journeys in the country started or ended in London in 2012/13 (GLA Economics 2016). Concentrating economic density has created agglomeration economies and increased productivity.

To remain at the top of global competitiveness, London continues investing in transit connectivity. Crossrail, scheduled to open in full in December 2019, is a new railway line running east to west through London and into the surrounding countryside. It will run over 100 kilometers of track, with a branch to Heathrow Airport. The main features of the project are the construction of 42 kilometers of new tunnels connecting stations in Central London, including a branch to Canary Wharf in east London, and the construction of 10 new stations.

Crossrail is Europe’s largest infrastructure project, with a projected cost of £14.8 billion. The project is being jointly sponsored by the Department for Transport and
Transport for London (TfL). Project delivery is being managed by Crossrail Ltd., a special-purpose subsidiary of TfL. The capital cost will be recovered from riders through farebox revenues; from businesses and developers, including BAA, the Canary Wharf Group, and the City of London through direct contributions to capital costs, developer contributions, and a business rate supplement (an extra payment on some business property); and from national taxpayers through a grant from the Department for Transport.

Crossrail will deliver significant travel time reduction (up to 40 percent on some routes), a 10 percent increase in London’s rail-based public transit capacity, and a 50 percent increase in capacity to the Isle of Dogs (an area in the East End of London), where the business district of Canary Wharf has the highest job density in London and in Europe, rivaled only by Wall Street and (eventually) the new Hudson Yards development in New York (see chapter 5). It will provide new transport links with the London Underground, Thameslink, the National Rail, the Docklands Light Railway, and the London Overground.

More than 200 million passengers are projected to use Crossrail annually. It will offer a direct connection between all of London’s main business centers, linking Heathrow with Paddington, the West End, the City, and Canary Wharf. According to GVA (the largest independent property agency in the United Kingdom), the improvements in travel times, the quality of passenger experience, and the frequency of rail service will have significant impacts on London’s economic performance and new residential and commercial investment, through a transformational effect on key locations along the route.

**Increasing Node Value by Reinforcing Highly Connective Hubs in Central London**

London’s public transit system has been central in shaping a radial monocentric city with a high concentration of hubs in the core. Its network has guided and constrained the city, with public transit networks central to growth during the 19th and first half of the 20th century.

Map 7.2 shows the percentage of commuting trips made by public transit, according to place of residence (panel a) and destination (panel b). High transit accessibility to the city center has fostered a highly concentrated distribution of jobs in the city hypercenter, with a more dispersed pattern of residential density. The result is that two-thirds of commuting flows originate or terminate in Outer London.

Two main mechanisms drive node value in London: the concentration of transit hubs in the core of the city where most employment and GDP creation takes place, and accessibility patterns that are highly concentrated in the core of London. Map 7.3 shows how the three network centralities used in the 3V Framework are concentrated in Central London (chapter 2). The highest levels of centrality—and thus accessibility—within the network and the greatest growth potential are around the Circle Line and along the Central Line, defining Central London. The density of stations is higher in the western part of Central London, where one third of London’s jobs are located.
MAP 7.2 Percentage of Commutes Made by Public Transit, by Place of Origin and Destination

a. By place of origin

b. By destination


Note: The height of the grid cells indicates resident population (panel a) and employment (panel b) densities in 2011. People who work at home are excluded from the totals.

MAP 7.3 Degree, Closeness, and Betweenness Centralities in the Underground in Central London

a. Degree centrality

b. Closeness centrality

c. Betweenness centrality

Source: © Urban Morphology and Complex Systems Institute. Used with the permission of UMCSI. Further permission required for reuse.
Crossrail stations within the area defined by the Circle Line will increase the importance, centrality, and accessibility of Central London’s major hubs. Crossrail station interchanges with existing tube stations and High-Speed 1 (HS1) stations will create very high node values, calling for further urban development to align place value with the very high node values of the most central stations. Main hubs, where jobs are already concentrated, will have more connections and will concentrate more lines after Crossrail. These major hubs at the top of London’s transit system hierarchy are in close proximity. Crossrail will also create a new direct connection between the National Rail networks running into Paddington and Liverpool Streets; passengers will no longer have to change at the termini of the National Rail routes. Crossrail is expected to have three main benefits:

- It will relieve overcrowding on existing Tube and train services by adding 10 percent extra rail capacity for London, the largest single increase in London’s transport capacity since World War II.
- It will strengthen links to key financial centers (Heathrow, the West End, the City, and Canary Wharf) to support London as a world city and bring an additional 1.5 million people within 45 minutes commuting distance of London’s key business districts.
- It will reduce travel times into and across London, with reliable and efficient service and 24 trains per hour at peak times through Central London.

**Increasing Place Value through Place-Making, Redevelopment, and the Public Realm**

Crossrail delivers integrated designs for stations, above-station developments, and public spaces. Each element complements the others to create places and transform spaces.

Crossrail Limited, which is tasked with delivering the new railway, coordinates master planning of public realm improvements around stations. The aim is to ensure that these improvements are integrated with existing and planned improvements in the wider area and reflect other planned uses. Master plans are developed with key stakeholders, including local authorities and private developers. The approach recognizes that passengers will judge the success of the railway not only by the service and the stations but also by their overall experience arriving at and departing from stations.

Crossrail’s approach to public spaces aims at making the areas outside stations work effectively as transport interchanges, getting people to the next stage of their journey by bicycle, foot, bus, or taxi and being an attractive and pleasant public space to spend time in. The designs aim to be adaptable and sustainable, so that their use can change over time. All Crossrail stations will be accessible from street to platform, safe, and secure.

The station area designs also aim to retain the identity, diversity, and characteristics of local areas, giving confidence to local communities and potential investors (photo 7.2). Toward that end, boroughs (local administrative units) play a vital part in raising funds for the designs, to ensure that such design will spread improvements and regeneration impacts. The designs were produced in collaboration with Crossrail, local authorities, TfL, and (on Crossrail’s surface section) Network Rail.
By March 2014 urban realm designs had been completed for 31 stations, including 27 in the London area and 4 outside London. They covered more than 100,000 square meters of improved public space at 40 sites—the equivalent of 19 Leicester Squares. The “Crossrail effect” is already happening in the center of London, at locations such as the east end of Oxford Street, while developers are also showing interest in outer London locations such as Abbey Wood and Southall.
The funding required to implement the designs will be obtained from a variety of sources, a principle agreed to by all the partners at an early stage. Crossrail estimates the total cost of the urban realm improvements outside every station on the route at £129 million. The target is to raise and implement £90 million of improvements by Crossrail’s opening. The funding will be split between Crossrail, TfL, and third parties (principally local authorities through developer contributions).

London property value analysts widely recognize that a driving force behind Crossrail’s ability to support development activity and property market values is investment in the extent, configuration, and quality of public space immediately around each station. According to GVA, the new stations, developments above the stations, and planned urban realm improvements have the potential to redefine Crossrail’s stations as the centers of the communities they serve, as attractive places with entertainment, public art, restaurants, and public spaces—places to spend time in, not just to pass through.

Examples of urban realm improvements along Crossrail line moving west to east are outlined below. They show how place value can be enhanced areas contexts.

**Maidenhead**

Maidenhead Station, on the west end of the line, is a gateway to a town through which about 3.5 million people pass each year. The main proposal includes creation of a new landscaped station plaza with a water pool acting as a focal point.

**IMAGE 7.1 Water Pool Focal Point at Maidenhead Station**

Source: © Crossrail Ltd. Used with the permission of Crossrail Ltd. Further permission required for reuse.
that will animate the space and encourage people to linger (image 7.1). Tree planting, high-quality paving materials, sensitive lighting, and seating will help provide a positive experience for passengers arriving by rail.

**Paddington**

Paddington is a historical Central London railway terminus and Underground station. It is a busy complex served by four underground lines: Bakerloo, Hammersmith & City, District, and Circle. Crossrail will increase the ranking of Paddington as a major London hub.

An interim improvement scheme has been completed on the canal side outside the new Hammersmith and City Line entrance on Departures Road, opposite the Crossrail entrance. A permanent urban realm design scheme aims to complete the waterside public space within the Paddington Basin (image 7.2). Crossrail anticipates that “it will establish a clear, safe and accessible towpath alongside the canal, station entrance and office development, which will be built over the entrance. This will aid pedestrian movements and wayfinding from station exits and surrounding developments while maintaining the character and quality of the area by respecting the historical industrial character of the Basin” (Crossrail 2015b).

Crossrail has also obtained planning consent from the Westminster City Council to build a 32,000-square meter development at Paddington Triangle (image 7.3).
IMAGE 7.3 New Development at Paddington Triangle

Source: © Crossrail Ltd. Used with the permission of Crossrail Ltd. Further permission required for reuse.
Note: Architect: Grimshaw.

IMAGE 7.4 Integration of Surrounding Area at Bond Street Station

Source: © Crossrail Ltd. Used with the permission of Crossrail Ltd. Further permission required for reuse.
Note: Architect’s impression of urban realm proposal. Urban realm designers: John McAslan & Partners. WSP/Publica.
**Bond Street**

Bond Street is a major historic retail street in London. The new urban realm design for Bond Street West takes into account an increase in pedestrian use. It sensitively integrates the new Crossrail station entrance with the surrounding environment. Proposals for Bond Street East will provide ample area for pedestrians, creating a prominent and generous forecourt to the station entrance. High-quality granite paving will extend into the station concourse. Four diagonal crossing points will be introduced on Hanover Square with adjacent footways in matching materials. Cycle parking will be provided at several locations in the square (image 7.4).

**Tottenham Court Road**

Tottenham Court Road Station will link the West End to Canary Wharf in 12 minutes, Stratford in 13 minutes, and Heathrow in less than 30 minutes. It will cut travel times in half in some cases.

Crossrail is investing £1 billion to transform the station, making it the biggest transport investment in the West End in decades. Built more than 100 years ago as two separate Tube stations, Tottenham Court Road was not designed to cope with the almost 150,000 passengers a day who now travel through the station. Alongside the upgrade of the existing Tube station, Crossrail is building a new station the length of three football fields, four floors underground.
Planning approval has been granted for above-site development at Tottenham Court Road that will cover four blocks. It includes the first new West End theater in more than a decade and 50,000 square meters of high-quality retail, office, and housing space (map 7.4). Over Station Development (OSD) above Crossrail’s integrated ticket halls at Dean Street and Charing Cross Road will create a modern new space in this part of London (image 7.5)

Plans include a new public piazza around Centre Point, creating a distinctive new West End landmark (image 7.6). A new open pedestrian space linking Soho

**IMAGE 7.5** Over Station Development at Tottenham Court Road West/Dean Street

Source: © Crossrail Ltd. Used with the permission of Crossrail Ltd. Further permission required for reuse.
Note: Architect: Hawkins Brown.

**IMAGE 7.6** New Pedestrian Plaza below Centre Point Tower in London’s West End

Source: © Crossrail Ltd. Used with the permission of Crossrail Ltd. Further permission required for reuse.
Note: Design team: Atkins/Gillespies/AHMM.
Square and Charing Cross Road will provide new views of the square and of St Patrick’s Church, among other open spaces.

**Liverpool Street East**
Liverpool Street Station is a key gateway to the City of London (also known as the Square Mile), Europe’s leading financial center. It is a destination for 73 million people a year who use the Underground and 63 million who use the national rail on their way to work, as visitors to the City, or en route to the nearby areas of Spitalfields and Shoreditch. The compactness and density of the Square Mile means that walking is the best way to move around the City. The arrival of Crossrail will see significant increases in pedestrian movements and other transport modes to get to and from the station (image 7.7).

**IMAGE 7.7 Pedestrian Walkway at Liverpool Street East**

![Image of pedestrian walkway at Liverpool Street East](image)

Source: © Crossrail Ltd. Used with the permission of Crossrail Ltd. Further permission required for reuse. Note: Architect’s impression. Urban realm designers: Urban Movement/Mott MacDonald.

**Whitechapel**
The refurbished entrance to the station on Whitechapel Road will see a larger forecourt with distinctive paving (image 7.8). Improvements to the area include the pedestrianization of Court Street, with the raising of the carriageway to create a safer walking route.
Abbey Wood
The arrival of Crossrail is a catalyst for the regeneration of Abbey Wood. The new station will act as an “urban bridge” by providing a direct and accessible link between the areas to the north and south of the station. As part of the wider urban realm proposals, Harrow Manor Way will be transformed from a four-lane urban motorway to a more traditional road with pavements and dedicated cycle lanes. It will link southbound bus stops to the station via a new pedestrian crossing (image 7.9).

IMAGE 7.9 Regeneration of Abbey Wood

Source: © Crossrail Ltd. Used with the permission of Crossrail Ltd. Further permission required for reuse. Note: Architect’s impression. Urban realm designers: Urban Movement.
Canary Wharf

Canary Wharf (photo 7.3) has the highest density of jobs and office space in London, with about 105,000 jobs on 28.8 hectares (an average gross built density of office space of 7.4). Its history over the past 20 years provides an example of the role of investment in public transit and in place-making supporting and sustaining economic growth. The three-value interplay is prevalent at Canary Wharf: Place-making and a 50 percent increase in transit capacity are expected to allow a doubling of office space in London’s fastest-growing business center.

The Docklands, once part of the Port of London in east and southeast London, experienced rapid expansion with the extension of the Jubilee Line, in 1999, enabling current employment levels to be reached; the previous transport systems would not have been able to cope with the number of passengers who now commute to Canary Wharf on the Jubilee Line. The combination of connectivity with high quality public realm allowed a former industrial site to be transformed into a booming business district.

In 1985, SOM, an architecture, engineering, and urban planning firm, began work on a master plan for Canary Wharf, which called for transforming a derelict industrial area into a thriving financial district. The master plan established a clear urban framework of streets, public squares, and green space. SOM worked with local artists and landscape architects to create memorable and functional gardens, plazas, fountains, shopping arcades, and waterfront promenades. It also enhanced

PHOTO 7.3 High-Quality Space at Canary Wharf

Source: © Françoise Labbé. Used with the permission of Françoise Labbé. Further permission required for reuse.

PHOTO 7.4 Connecting Canary Wharf through the Jubilee Line Station

Source: © Françoise Labbé. Used with the permission of Françoise Labbé. Further permission required for reuse.
tree-lined boulevards (photo 7.5). To establish aesthetic continuity, SOM proposed that design elements such as cornice lines, stone bases, and street furniture be consistent throughout the site.

The Canary Wharf Crossrail Station (photo 7.6) will cut travel time to the City (Liverpool Street) from 21 minutes to 6 minutes, with a train every five minutes at

**PHOTO 7.5 Memorable Green Space at Canary Wharf**

Source: © Françoise Labbé. Used with the permission of Françoise Labbé. Further permission required for reuse.

**PHOTO 7.6 Iconic Crossrail Station at Canary Wharf**

Source: © Françoise Labbé. Used with the permission of Françoise Labbé. Further permission required for reuse.

Note: Architectural design: Norman Foster.
peak time in each direction. It will trigger high agglomeration economies between the two densest and fastest-growing economic cores of London. Travel time to Paddington will be cut by from 33 to 17 minutes; travel time to Heathrow will fall from 55–90 to 39 minutes.

The 250-meter-long station being built for £500 million is surrounded by the water of the West India Quay dock. Designing a station to be built 18 meters below water level presented significant design challenges but resulted in optimum access to and through the Canary Wharf Estate while retaining a navigable channel for boats within the dock. The station and proposed retail and park areas will be seven floors high. Retail areas are planned for three of the seven floors, along with a landscaped garden, restaurant, and community facility on the top floor.

The development includes a timber lattice roof and rooftop garden level that sit above the three-story retail development (photo 7.7). It lets in light and rain for natural irrigation. Sustainably sourced beams provide a warm, natural counterpoint to the glass and steel towers of Canary Wharf.

The decision to expand Canary Wharf eastward allowed the developer to build up to 3,610 new homes, 1.9 million square meters of office space, 35,000 square meters of retail floor space, a community center, and a network of public squares, with a public space of 3.6 hectares in the first stage. The new office space will be designed to accommodate the technology media and telecommunications sector, as well as financial and professional services firms. The new station acts as a bridge between two communities, Canary Wharf Estate and Poplar, to the north. The extension will offer high street retail units to complement Canary Wharf’s existing retail offer. It will also include affordable housing, substantial new green parks and dockside walks, a library, a large surgery, a school for 420 children, a community sports hall and community spaces.
Increasing Market Potential Values, Particularly at Key Locations

London generates approximately 22 percent of Britain’s GDP (City of London Corporation 2011). It shifted to a mostly service-based economy earlier than other European cities. Currently, more than 85 percent of the employed population (3.2 million) of Greater London works in service industries.

London’s economic advantage lies in its extremely dense employment clusters. Its highest-value economic activity occurs in agglomerations of banking, insurance, financial, professional and business services, and creative industries. For businesses in these sectors, proximity to each other creates more opportunities for specialization in client and labor markets as well as increased potential for knowledge-sharing. Such agglomeration makes London significantly more productive than the United Kingdom as a whole.

In an advanced service economy, such as London, local job densities and accessibility to jobs are key components of market potential value. The more accessible
a place is, the more it concentrates jobs. Employment has been declining significantly in Outer London, while increasing in Inner London and its densest areas. In contrast, in the City of London, density increased 30 percent in 10 years. Extremely high job density can be achieved only with an extensive network of transport connections and a high density of transport hubs in the center (photo 7.8).

Two-thirds of Greater London’s GDP is produced on 20 percent of its land area (Inner London). Fifty-six percent of all private sector jobs in Greater London are located in Inner London. Most of Inner London’s economic activity is concentrated in 10 percent of its area, in Central London. Central London concentrates 1.5 million jobs, 30 percent of Greater London’s employment, in about 30 square kilometers, or 2 percent of London land space (map 7.5 and Figure 7.1).

A report by Colin Buchanan and Partners analyzes the impact of the number of people accessible within 45 minutes on employment densities in specific London locations (GLA 2004). It concludes that as accessibility increases, employment density can increase. Employment density by borough in London is correlated with the number of people that can access the borough in 45 minutes by transit. Firms locate where they can access a large number of people and other firms; people locate where they can access a large number of jobs opportunities.

Within the spike of wealth and economic might of Central London—the highest in Europe—the City of London stands out. In a 3 square kilometer area that represents just 0.2 percent of Greater London, the City generated £45 billion in

**MAP 7.5 Employment Density in Greater London, 2014**

Source: © Urban Morphology and Complex Systems Institute. Used with the permission of UMCSII. Further permission required for reuse. Data are from the London Datastore, Greater London Authority.
economic output in 2014, equivalent to 14 percent of London’s output and 3 percent of the United Kingdom’s output.

London’s high-density specialized clusters benefit from agglomeration advantages: knowledge-sharing spillovers, shared specialized labor markets, and economies of scale in markets for clients, customers and intermediate inputs. Advanced services are concentrated in Central London at high density. Jobs in finance and business jobs, information and communications technology (ICT), creative industries, science and engineering, and research and development represent about 25 percent of Greater London jobs. Different service industry types follow different patterns of concentration and different spatial dynamics (map 7.6).

Changes in employment density have a strong impact on market potential values. Spatial concentration of jobs increased between 2000 and 2010 (Smith 2012), fostering high market potential values in Central London. Densities have increased in already dense areas (map 7.7 and photo 7.5). Over the next 10 years, agglomeration trends are expected to continue to drive economic growth in the City of London, which is projected to grow at an average rate of 2.8 percent a year. Employment (estimated at 396,800 in 2014) is projected to reach 435,700 by 2025, and productivity is projected to rise by 1.9 percent a year through 2025.

**Housing prices in Greater London**

Housing in the United Kingdom is worth about £6 trillion (Savills 2016). The distribution of housing assets is very uneven. Housing in Inner London is worth a third more than all the housing in Wales and Scotland put together (Stringer 2014). This concentration of housing property value derives from the differences in accessibil-
Increasing Connectivity and Economic Value along a Transit Line: Crossrail in London

A study by Knight Frank shows that 91 percent of tenants in London want to live within 1 kilometer of a transport link (Knight Frank 2015). Office density and rent in London

London office market is complex and made of highly specialized established and emerging subcenters. Five major business districts (the City, Westminster, Canary Wharf, Camden and Islington, and Lambeth and Southwark) represent less than 5 percent of Greater London but concentrate 75 percent of its office space.
London office prices are strongly correlated with transit access to jobs, transit access to people, and the historical quality of the urban fabric (measured by the proportion of buildings placed on the Statutory List of Buildings of Special Architectural or Historic Interest) (Smith 2012). Accessibility variables are the most influential. Prices are higher in West London than elsewhere because of its connectivity (particularly to Heathrow Airport) and prestige, which stem from its impressive urban realm and high-quality historic architecture.
High prices in the West End are also linked to urban development dynamics. Urban development in London between 2000–10 experienced massive intensification, with the construction of 8 million square meters of new office space, leading to a total of 26.4 million square meters of office space in 2010. Development was restricted in the West End for policy and heritage reasons. Rapid expansion in the City of London and Canary Wharf initially led to a softening of prices (Smith 2012).
The different office markets follow different patterns of firms clustering and specialization. Higher rents in the West End than in the City and Canary Wharf have not led to businesses migration. Firms in the City are highly specialized in finance, with linkages between banks, insurance, management consultancy, accounting, legal services, and fund asset management. Firms in the West End are more diversified, with creative industry clusters. The London office market is thus made of submarkets with very high local specialization (Smith 2012). Development trends reinforce patterns of firm clustering. The division between east and west is growing, with development having different effects on prices (map 7.9).

**Differential effects of Crossrail on market potential**

Real estate prices around station areas will not benefit equally from the increase in connectivity. The complex spatial structure of London real estate markets explains the different market potential values along the Crossrail line. In addition to the dynamic interplay of node and place value enhancements, markets have their own logic (demand and supply, market vibrancy) that must be taken into account in devising transit-oriented development (TOD) spatial strategies. This section analyzes both the overall effect of Crossrail and the differentiated effects on market potential along the line.

Crossrail will bring an additional 1.5 million people within a 45-minute commuting distance of London’s key business districts (the West End, the City, and Canary Wharf) (map 7.10). It will create direct connections to Heathrow Airport for Central and East London and increase the interchange roles of Farringdon and Stratford. It will decrease travel times between Canary Wharf and the City, strengthening the role of Liverpool Station as a major interchange connecting seven railway lines with trains to Southend and Stansted. Crossrail will also link new emerging centers in Inner London to the major established centers. It will enable the regeneration of areas around stations along its route by increasing accessibility with shorter travel times.
Increasing Connectivity and Economic Value along a Transit Line: Crossrail in London

MAP 7.10 Projected Impact of Crossrail on Accessibility to Jobs

Source: © Crossrail Ltd. Used with the permission of Crossrail Ltd. Further permission required for reuse.

times and giving employers located along the route better access to a larger, more highly skilled labor market. It will likely attract new private sector development and increase employment densities near Crossrail stations. More than 100,000 additional jobs could be created across the Thames Gateway, with Crossrail directly serving Custom House, Woolwich, and Abbey Wood and improving connections to other networks in the area (Crossrail 2011).

A property impact study covering the period 2012–21 reached the following conclusions (Crossrail and GVA 2012):

- Crossrail is already having an impact on investment decisions. At many locations it will be influential in supporting and accelerating new development.
- Crossrail could help create additional residential and commercial value of as much as £5.5 billion along the route between 2012 and 2021.
- Crossrail will support the delivery of more than 57,000 new homes and 3.2 million square meters of commercial office space that have been identified for development within 1 kilometer of stations along the route.
- Commercial office values around Crossrail stations in Central London will increase as a result of Crossrail over the next decade, with an increase of 10 percent above a rising baseline projection. Residential capital values immediately around stations in Central London will rise by about 25 percent, and values in the suburbs will rise 20 percent above the rising baseline projection in the period.
- Urban realm improvements and the development of new schemes above Crossrail stations will act as a highly visible and beneficial driver for further development activity; the intensification of use; and in several areas, such as Farringdon, significant change.
Crossrail will have a transformative effect on the property market and development activity over time. This overall increase will not be evenly distributed.

Along the length of the entire line, from Maidenhead to Shenfield, prices within a short walk of stations rose only 5 percent more than the local market between 2008 and 2014, gaining 43 percent on average. Some areas saw prices soar, however. In Central London, Farringdon and Paddington outperformed the local market by about 24 percent. Average prices within a 10-minute walk of stations in Central London rose 57 percent, according to analysis by the London estate firm Knight Frank, while prices close to the Bond Street Station rose 82 percent, the largest increase along the route (Knight Frank 2015).

The most significant improvements can be expected to occur where large changes in connectivity coincide with major development opportunities. Within Central London, heritage constraints will limit the development response to increased transport capacity in the West End. In the City a more liberal planning regime should allow densification where connectivity is improved.

Crossrail and Thameslink will create a new and highly significant transport interchange at Farringdon, where increased connectivity will vastly enhance development and job potential (CB Richard Ellis 2009). The impact of transport change will be most dramatic in fringe locations, where opportunities for development are plentiful. In markets such as the Isle of Dogs, Stratford, and Paddington, transport will play a leading role in the transformation of property markets. The stations along the Crossrail route where property prices have outperformed the market are the ones located in Central London where both jobs and connectivity are highly concentrated (map 7.11).

The greatest changes to the property market are expected to be in East London. The stock of office space in the Isle of Dogs could double by 2020, with Crossrail as key driver. It will provide direct access to Heathrow and West London for the first time, as well as improved access to Central London. The

MAP 7.11 Property Price Performance along the Crossrail Route
Increasing importance of London City Airport will also be a stimulus. Crossrail will also play a key role at Stratford, where it will create a direct link to the City and the West End (HS 1 has already put Stratford on the international rail network).

The Paddington office market could also double in size by 2020. Skylines could be reshaped at King's Cross, Euston, Victoria, and Southbank, as developers seek to capitalize on the existing quality of transport connections and improvement to existing networks.

Building a typology of nodes along Crossrail
According to GVA, Crossrail will reinforce the central spikes of high node and market potential values, a phenomenon that occurred in Seoul in 1998 after completion of the second phase of its subway. Given the strength of existing Central London office groupings, Crossrail is unlikely to create new markets or major locations of new demand in its own right, but it will be instrumental in reinforcing and strengthening office clusters and supporting demand in established locations. Maintaining values in high value areas can be as important as increasing them in more modestly priced locations.

According to CB Richard/Ellis 2009, Crossrail will create new opportunities and risks for both core and fringe markets (table 7.1). The current transport system favors core markets within London, because these markets evolved where transport links were good and transport improvements were made to improve access to them. Given that these areas are already well endowed with transport links, the effects of improved transport will be incremental.

By comparison, fringe locations (where provision of new transport infrastructure will create an imbalance between a higher node value and a comparatively low place value) benefit from the transformational effects of new links and increased capacity. The risk to fringe markets is that increased transport capacity at the core reinforces agglomeration effects that further strengthens its position relative to the periphery. These risks are counterbalanced by the possibility of benefiting from the boost to the profitability of potential developments.

<table>
<thead>
<tr>
<th>TABLE 7.1 Opportunities and Risks in Core and Fringe Markets</th>
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<td><strong>Opportunities</strong></td>
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Source: Siebrits 2009 © CBRE. Used with the permission of CBRE. Further permission required for reuse.
CB Richard Ellis proposes a typology based on connectivity (node value increase) and development potential (place and market potential value increase) (figure 7.2). The greatest growth potential is where high levels of office development match high increases in connectivity.

Halfway through the construction process, some neighborhoods are already seeing benefits from incoming stations, while others have yet to do so. Although Crossrail will spur economic growth mainly by reinforcing the core advanced service economy nodes, such as Canary Wharf, there are development opportunities for a variety of communities along the route, provided they adopt the right development strategies.

Development of less central stations requires careful planning. In particular, surface-level transport interchanges must fully integrate different transport modes in a seamless way. Cycling and pedestrian access and the approach to the station have major impacts on station use and perception, for example. High-quality station and public realm design plays a major role in attracting investment, improving perception and community amenities, and gaining or retaining retailers.
lar, new streets connecting to stations should be phased in with other developer initiatives, so that works can be combined. Financing alternatives should be explored if developer contributions are not phased in in tandem with station works. Plans need to allow for flexibility and adaptation to changes in demand. Some areas will take longer to benefit. The character of some places will change—from town center to residential, industrial to commercial, quiet to busy, or any number of shifts. Such transformation calls for a long-term view from all parties involved, built on a partnership with transit agencies and local authorities to develop high-quality plans that can deliver social as well as financial returns.

Crossrail’s experience in fringe stations shows that TOD can achieve even more in terms of station-area regeneration and its effect on local economies and social inclusiveness if consideration is given to the nonrail aspects of infrastructure programs from the outset. A recommendation is to build or increase skills and employment services, especially in areas where connectivity is opening new opportunities for job creation.

Crossrail has prepared integrated designs for 12 major property developments over and around its key Central London stations (Crossrail 2015a). Development plans cover more than 280,000 square meters of high-quality office, retail and residential space. The receipts from property developments are targeted to generate income of approximately £500 million as part of the core Crossrail funding strategy. Crossrail and its partners have gained planning consent for the majority of the schemes; the last few planning applications have been submitted.

**Benefit to Cost Ratio and Economic Benefits of Crossrail**

**Benefit to Cost Ratio**

The conventional economic appraisal of a transport project focuses on factors such as travel time savings and travel quality benefits, assessing them against the total cost of the project. Such appraisals have long been used to assess the relative attractiveness of different transport projects by assigning monetary values to benefits and costs for Crossrail. This analysis yields a benefit to cost ratio of 2.59 based on a U.K. value of time and ratio of 3.64 using a London specific value of time (table 7.2). The project thus generates substantial net transport economic benefits. More than 40 percent of these benefits are associated with the increase in the capacity of London’s congested transport network to meet the existing and future transport needs of London (Crossrail 2011).

**Wider Economic Benefits**

The conventional appraisal methodology considers only the direct transport benefits and costs. But a major project such as Crossrail will generate economic benefits that are not included in a standard benefit-cost calculation. The Department for Transport identifies four components of these wider economic benefits: move to more productive jobs, pure agglomeration, increase in labor force participation, and impacts on imperfect competition.
Crossrail will have a substantial effect on the U.K. economy. According to Ian Lindsay, Land and Property Director, at the peak of construction, Crossrail will directly employ about 10,000 people. Supply chain benefits in the United Kingdom are projected to be three times higher than actual investments. More than 1,000 contracts have already been put out to bid, and 90 percent of the budget is being spent in the United Kingdom. Crossrail is aiming to leave a skills legacy by reviving tunneling and underground construction skills in the United Kingdom (Lindsay 2012).

Crossrail supports a transport system that is an engine for economic growth. Improved public transit is one of the major prerequisites for attracting more jobs and residents, delivering and facilitating the growth forecast in The London Plan 2016 (City of London 2016). More than 35 percent of future employment growth in London is expected to be located in areas well served by Crossrail services (the West End, the City, and Canary Wharf). Like Hudson Yards in New York (see chapter 5), Crossrail is a central component of a strategic planning policy aiming at reinforcing the existing high concentration of jobs in the core city to reap the highest possible agglomeration economies.

**Notes**

1 This chapter does not account for any effect Brexit may have on the concentration of advanced services in London.

2 Public transit include bus, coach, metro, tram, train, and river bus trips.

3 Railways first arrived in London in 1836. Most initial developments were intercity. The 1846 Royal Commission on Railway Termini prevented train lines from entering Central

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**TABLE 7.2 Estimated Benefits and Costs of Crossrail (billions of £)**

<table>
<thead>
<tr>
<th>Component</th>
<th>Transport for London (London value of time)</th>
<th>Department for Transport (U.K. value of time)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>User benefits</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time savings</td>
<td>9.1</td>
<td>6.6</td>
</tr>
<tr>
<td>Congestion relief</td>
<td>7.3</td>
<td>5.3</td>
</tr>
<tr>
<td>Other</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Indirect tax revenue</td>
<td>–1.4</td>
<td>–1.4</td>
</tr>
<tr>
<td>Total user benefits</td>
<td>15.5</td>
<td>11.0</td>
</tr>
<tr>
<td><strong>Costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital expenditures</td>
<td>–8.0</td>
<td>–8.0</td>
</tr>
<tr>
<td>Operations and maintenance</td>
<td>–3.6</td>
<td>–3.6</td>
</tr>
<tr>
<td>Revenues</td>
<td>7.4</td>
<td>7.4</td>
</tr>
<tr>
<td>Other</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Total user costs</td>
<td>–4.2</td>
<td>–4.2</td>
</tr>
<tr>
<td><strong>Net present value</strong></td>
<td>11.2</td>
<td>6.7</td>
</tr>
<tr>
<td><strong>“Conventional” benefit-cost ratio</strong></td>
<td>3.64</td>
<td>2.59</td>
</tr>
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Source: Crossrail 2011.

Note: Figures are present values based on first quarter 2002 prices.
London, resulting in a ring of disconnected stations; the ban stimulated a market for interconnections and development of the underground (Levinson, Giacomin, and Badsey-Ellis 2016). Both surface rail and underground networks expanded together, producing both competition and synergy between the two modes. Transportation development played a significant role in suburban expansion, with railway companies forming business relationships with property developers, in some cases acting as property developers themselves.

4 This section draws on materials from Crossrail.

5 Although it is the richest area in Europe, Inner London is not uniformly rich: There is a strong divide between West and East. Inner London West produces twice the gross value added of Inner London East on less than one-third its area. Inner London West has GDP per capita 3.6 times higher than Inner London East. This division between East and West is growing, as reflected in the price of office space.

6 Greater London covers 1,572 square kilometers and has a population of 8.2 million people; Inner London covers 319 square kilometers and has a population of 3.2 million people; Central London (based on London Plan) covers 30 square kilometers; the City of London covers 2.9 square kilometers and has a population of 8,000, reflecting its role primarily as an economic center. Population data are based on the 2011 census.

7 This part of the chapter draws on Crossrail and GVA (2012).

References


Integrating the Space Economy with Transit-Oriented Development: Increasing Economic Efficiency and Social Inclusiveness in Zhengzhou

This case study widens the geographical scope of the 3V Framework to the scale of a large city (Zhengzhou). It analyses the impact of the first six planned subway lines (map 8.1), examining development potential of 21 stations along the city’s Line 3 in detail. It shows how the 3V Framework can help develop a long-term vision for the most efficient shape of densities (people, job, and economic) to increase economic growth and productivity while decoupling economic growth from infrastructure costs and energy use. It highlights how to devise local strategies for urban development around specific transit nodes, taking into account their node, place, and market potential values. It also shows how the approach to transit-oriented development (TOD) used in highly efficient cities can be applied in rapidly growing cities, particularly in China.

This chapter makes recommendations at three levels:

- At the metropolitan level, it recommends integrating Zhengzhou’s space economy and labor market with transit, in order to foster economic growth through agglomeration and increase productivity, competitiveness, and inclusiveness.
- At the network level, it recommends increasing accessibility by matching economic and people densities with the most accessible and central parts of the subway network.
- At the local level, it recommends increasing place and market potential values in order to reap the benefits of land value capture finance.
Zhengzhou is the provincial capital of Henan Province in central China. The city—one of the eight great ancient capitals of China—lies on the southern bank of the Yellow River. As a prefecture-level city, it serves as the political, economic, technological, and educational center of this large province (home to more than 94 million people).

Zhengzhou is a major transportation hub, located at the intersection of the Longhai Railway and the Beijing-Guangzhou Railway. The high-speed railway network provides service from the city to Beijing, Nanjing, Xi’an, Wuhan, and Shanghai. The new high-speed railway station (the Zhengzhou Dong Station) is one of the largest in Asia. Because of its strategic location, Zhengzhou is increasingly attracting domestic and international investment as well as migrants, transforming the city into one of China’s large economic centers (EIU 2012). GDP per capita of Zhengzhou was ¥77,217 in 2015.

Zhengzhou has a population of 9.6 million inhabitants and an area of 7,446 square kilometers. Its urban population of 6.4 million live on 1,010 square kilometers, including a built-up area of 438 square kilometers, according to the municipal government. It is the second-largest city in central China, after Wuhan.

The National Development and Reform Commission approved the plans for Zhengzhou Metro Lines 1 and 2 in February 2009. This rapid transit rail network will serve both the urban and suburban districts of Zhengzhou. The subway
extension will increase the productivity, livability, and attractiveness of the city for businesses and investors.

To transform connectivity and accessibility enhancements into increases in GDP, it is essential to coordinate the intensity of land use around transit stations and economic plans (UN-Habitat 2015). Cross-country experience suggests that the intensity of land use should not be evenly distributed across the city but should peak where transit accessibility to jobs is greatest. Firms locate where they can increase their productivity through agglomeration and localization effects. Zoning policies should allow for and promote densification of the most accessible areas.

Shaping densities (people and jobs) based on transit accessibility and connecting people to jobs in a seamless, integrated way though many modes (planes, high-speed rail, regional trains, subways, buses) and across many geographical scales is essential to boost economic development, make most efficient use of resources, and minimize infrastructure cost. Seamless integration of scales and modes should be ensured at efficient and compact interchange hubs, which provide good opportunities for urban development if neighborhoods are permeable, pedestrian oriented, and vibrant.

**Economic and Human Densities in Zhengzhou**

Zhengzhou’s economy is concentrated (map 8.2). The concentration of GDP is similar to London’s and follows the Pareto principle (20 percent of the urban land...
produces 80 percent of the city’s GDP) (figure 8.1). This pattern is efficient and considered a valuable asset in global cities, because concentrated areas with high productivity are economic engines for the entire city that ensure a city’s global competitiveness and attractiveness. GDP density in Zhengzhou in 2009 follows an inverse power law distribution of exponent –0.89 (for an explanation of power law distribution, see appendix A).

Map 8.3 shows the projected decrease in human density (people and jobs) at the city core (areas marked in blue) and the increase at the disconnected periphery.

**FIGURE 8.1 Geographic Concentration of GDP in Zhengzhou, 2009**


*Note:* Eighty percent of Zhengzhou’s GDP is concentrated on 21 percent of its urban area (red area); 20 percent of its GDP is sprawled over 79 percent of its urban area (green area).
The projected scattering of people and jobs across a vast territory may reduce the city’s strong agglomeration effects.

Current planning does not foster a concentration of economic and residential densities around the most central parts of the subway network (map 8.4). Indeed, the city’s decentralization policies are projected to reduce densities in the most central and accessible places within the city core while relocating people and activities to peripheral zones that are less accessible—the opposite approach from that of New York and London. Such transformation would lead to a less efficient form of land use and transit integration.

This evolution would be accompanied by increasing imbalances in the jobs to residents ratio, with an increase in large mono-functional industrial zones in peripheral locations with weak connections to subway lines. As a result, Zhengzhou’s competitiveness and attractiveness for businesses would decline and travel times increase. Labor markets may become fragmented, reducing agglomeration economies and global welfare.

Instead, learning from the previous case studies, planning could match intensity of development across Zhengzhou with accessibility to people, jobs, and commercial space within 30 minutes by public transit, reinforcing already dense and accessible areas (which have higher potential for growth) rather than dispersing development with decentralization policies and new towns. It would require adjusting plans to allow better matching of increases in human densities with the increase in the number of accessible jobs delivered by the investment in new subway lines. Increases in connectivity and accessibility would lead to real estate growth and land values increases that could be partly captured by the public sector to pay for public investment and foster further local development. A new zoning system that differentiates floor area ratios (FARs) and land uses based on transit accessibility would allow Zhengzhou to develop a strategic TOD plan integrating...
economic, transportation, and land use planning. A match between jobs and transit would allow for a stronger integrated approach to spatial planning.

Residential and job densities in Zhengzhou are currently similar to those in competitive global cities such as Paris, London, and New York. Population density is high in central areas and low at the periphery (figure 8.2 and map 8.5), following an inverse power law of exponent –0.945 (see appendix A).

**FIGURE 8.2 Population Distribution across the Zhengzhou Metropolitan Area, 2012**

Note: Red area: 33 percent of the population (1.8 million inhabitants) lives on 2.5 percent of the metropolitan area (44 square kilometers). Density is more than 20,000 people per square kilometer, with an average density in the hypercore of 41,000 people per square kilometer. Green area: 30 percent of the population (1.6 million) lives on 6.5 percent of the metropolitan area (109 square kilometers). Density is 5,000–20,000 people per square kilometer, with an average density of 14,700 people per square kilometer. Grey area: 37 percent of the population (1.9 million) lives on 91 percent of the metropolitan area (1,570 square kilometers). Density is less than 5,000 people per square kilometer, with an average density of 3,300 people per square kilometer.

**MAP 8.5 Residential Density in Zhengzhou, 2009 and 2030**

The projected distribution of residential densities reveals a progressive increase, but large dense areas remain with little access to the subway network (map 8.5). Residential density is highly concentrated in 2009 (inverse power law exponent of –0.92). It is projected to become more smoothly distributed beginning in 2020 (inverse power law exponent of –0.66)—a development that reduced urban efficiency (figure 8.3).

Residential density within a 500-meter radius of subway stations reveals a strong imbalance between the western and eastern parts of the city (map 8.6). This imbalance will structure value, with a cluster of high residential density stations within the western part of the loop line.

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FIGURE 8.3 Residential Density in Zhengzhou, 2009, 2020, and 2030

GDP per capita and the employment rate are highest in four peripheral districts (map 8.7). This pattern reflects zoning that concentrates employees and industrial zones in districts with few residents.

The correlation between residential and economic densities demonstrates strong agglomeration economy effects (figure 8.4). They may be jeopardized by the spreading out of jobs across a vast territory (map 8.8). The analysis reveals a drop in the concentration of jobs under the impact of decentralization policies (figure 8.5), with the exponent of the power law falling from 1.51 to 0.74.

Analysis of job densities within a 500-meter radius of subway stations confirms the structural imbalance between the western part of the city and the eastern part.
Densities increase over time, but the imbalance remains. Jobs are decentralized, not clustered around subway stations. The projected decrease in density in the most connected part of the city will reduce market potential value in the urban center without creating strong market opportunities in the periphery, because areas planned for expansion are poorly connected to the subway network (maps 8.9).
Job growth is expected to occur mostly in the periphery, in some cases in large, disconnected zones. Large industrial zones will increasingly be scattered in peripheral locations and weakly connected to subway lines (maps 8.11 and 8.12). Their growth implies large increases in transport needs, mostly by road transport. The number of stations in the eastern part of the city with very high proportions of jobs to residents will grow, reflecting the increase in mono-functionality.
Case Study: Zhengzhou

MAP 8.11 Jobs to Residents Ratio in Zhengzhou, 2009 and 2030

[Map showing the Jobs to Residents Ratio in Zhengzhou, 2009 and 2030.]


MAP 8.12 Jobs to Residents Ratio in 500-Meter Catchment Area around Subway Stations in Zhengzhou, 2030

[Map showing the Jobs to Residents Ratio in the 500-Meter Catchment Area around Subway Stations in Zhengzhou, 2030.]


Impact of Transit-Oriented Development on Improved Job Accessibility in Zhengzhou

Li and others (2016) examined the average percentage of jobs accessible from each location within 45 minutes’ travel time by public transit, walking, and biking weighted by the population for different land use and transport investments. They showed that a significant increase in average job accessibility can be achieved when two complementary policies are combined: (a) a multimodal transit system that includes a well-developed subway network, supplemented by
buses and bicycle access, and (b) densification at high levels around subway stations. Both social inclusiveness and labor market integration increase under such scenarios.

Map 8.13 shows the share of jobs than can be accessed by public transit, walking, and biking to within 45 minutes by people in Zhengzhou. In the first scenario, which includes only metro lines 1, 2, and 3 (panel a), people have access on average to 12 percent of the jobs. Adding the bus network increases the share to 28 percent (panel b). Doubling the concentration of jobs and residents within an 800-meter radius of metro stations (the TOD scenario) increases the share to 39 percent (panel c). Also ensuring good bike access to the stations (through improved bike lanes and secured parking facilities, for example) increases the share to 46 percent (panel d).

**Node Value along Line 3**

Node value is the value a station acquires through its location in the network. Different network organizations create different distributions of node values. The shape of transit and infrastructure networks strongly affects agglomeration and the potential for land value capture. Increases in connectivity and accessibility increase the growth potential and the market potential value of urban places.
Line 3 has 21 stations, crossing some of the densest parts of Zhengzhou in the central northwest quadrant of the city and linking them to the east of Zhengzhou (map 8.14).

Centralities in subway networks play an important role in structuring node values. The northern part of the loop line, Line 5 (in red in map 8.15), and the major interchanges between lines stand out in terms of betweenness centrality (many different routes pass through the station). As in global cities (Tokyo, London) or large Chinese cities (Shanghai), the loop line in Zhengzhou has high betweenness centrality, linking the core and the spokes. Stations with high betweenness centrality capture large flows of passengers and thus have high market development potential. Centrality

**MAP 8.14 First Phase of Zhengzhou Line 3**

![Map of the First Phase of Zhengzhou Line 3](source: World Bank 2014)

**MAP 8.15 Closeness and Betweenness Centrality of the Zhengzhou Subway System**

a. Closeness centrality  
b. Betweenness centrality

![Closeness and Betweenness Centrality Maps](source: Urban Morphology and Complex Systems Institute 2016)
analysis is based on the network including six lines by 2020. The central part of Line 3 (in pink in map 8.15) has good closeness centrality (stations are close to other stations in the network) but weak betweenness centrality, except when it crosses Line 5.

Closeness centrality does not display a steep gradient (figure 8.6). Its values do not decrease according to an inverse power law but linearly. In contrast, the distribution of betweenness centrality follows an inverse power law (with an exponent of –0.72 in Zhengzhou), both for the entire system and for Line 3 (figure 8.7).

**FIGURE 8.6  Distribution of Closeness Centrality of the Zhengzhou Subway**

![Distribution of Closeness Centrality](image1)

Note: Blue line indicates the closeness centrality of stations. Grey line is the regression line.

**FIGURE 8.7  Distribution of Betweenness Centrality of the Zhengzhou Subway Network**

![Distribution of Betweenness Centrality](image2)


Note: Red dots indicate stations on Line 3. Grey line indicates the entire system.
The Node Value Index

The node value index is created from three subindexes based on daily ridership, centrality, and intermodal diversity.

- Daily ridership (in 2021 and 2028) is the current and projected traffic of each station.
- Centrality describes the accessibility of each station within the network and the number of routes passing through it. It is measured as a composite index of three types of centralities explained in Chapter 2, calculated at the scale of the entire network.
- Intermodal diversity describes the number of other transit modes at walking distance from the station.

Each metric was normalized in a subindex (with 1 as the highest value). The composite index is the mean of the three subindexes.

Subindex 1: Daily ridership

Data on ridership were extracted from a study of projected inbound traffic at stations in 2021 and 2028 for Line 3. Ridership is highest at strong, central attractive destinations, such as Er Qi Guang Chang and Dong Da Jie, and at interchange stations, notably stations that connect to loop Line 5, which have high betweenness centrality (figure 8.8).4


Note: To give more weight to the long-term future potential of each subway station, the 2028 ridership is given twice the weight of 2021 ridership in calculating the subindex. Stations are ordered from west to east.
Daily ridership follows an inverse power low distribution (with a coefficient of –0.7) (figure 8.9). This hierarchical property of ridership (also evident in Paris and London) makes this indicator an excellent candidate to calculate the node value index.

**FIGURE 8.9 Inverse Power Law Distribution of Subway Ridership in Zhengzhou 2021 and 2028**

![Graph showing inverse power law distribution of subway ridership](image)

Note: Blue arrows points to ridership in 2021; red arrow points to ridership in 2028.

**Subindex 2: Centrality**

Centralities for Zhengzhou Line 3 were calculated for the entire Zhengzhou subway network. The subindex is a weighted average of degree centrality, closeness centrality, and betweenness centrality.

Figure 8.10 shows the normalized closeness centrality index for Line 3 stations. It shows differences between core stations and spoke stations.

**FIGURE 8.10 Normalized Closeness Centrality Subindex of Line 3 Stations**

![Graph showing normalized closeness centrality](image)

Note: Stations are ordered from west to east.
Betweenness centrality has a steep gradient, distributed according to an inverse power law for both the entire network and Line 3 (figure 8.11).

**FIGURE 8.11** Ranking of Betweenness Centrality of Line 3 Stations

Note: The distribution of betweenness centrality for Line 3 follows an inverse power law with a coefficient of –1.

Figure 8.12 shows the normalized index of betweenness centrality of stations on Line 3. It shows higher values for stations connecting Line 3 with Line 5.

**FIGURE 8.12** Normalized Betweenness Subindex of Line 3 Stations

Note: Stations are ordered from west to east.
Figure 8.13 gives the aggregated centrality index, a weighted average of degree (0.2), closeness (0.2), and betweenness (0.6) centrality. Figure 8.14 shows the rankings of the stations.

**FIGURE 8.13 Aggregated Centrality Subindex for Line 3 Stations**

The aggregated subindex of centrality follows an inverse power law (figure 8.14). The strong betweenness hierarchy is muted by the more linear closeness centrality.

**FIGURE 8.14 Ranking of Line 3 Stations by Subindex of Centrality**

Note: Stations are ordered from west to east.
Subindex 3: Intermodal diversity
Intermodal diversity captures the number of complementary modes (bus and bus rapid transit routes) that are within walking distance from a station. Figure 8.15 shows higher intermodality at the city center than at the periphery.

FIGURE 8.15 Normalized Intermodality Subindex of Line 3 Stations

Comparison of node value subindexes reveals imbalances in connectivity (figure 8.16). The station with the highest ridership (Er Qi Guang Chang) has a

FIGURE 8.16 Subindexes of Daily Ridership, Centrality, and Intermodal Diversity

Note: Stations are ordered from west to east.
moderate value of intermodality, whereas a station with high centrality and ridership, such as Zhong Xing Lu, has currently almost no intermodal diversity (reflecting its location in an area of underdevelopment). Peripheral stations have less intermodality than more central stations. The interplay of the different structural properties of the three centralities constitutes a subframework for analyzing the dynamics of node value.

Aggregated node value index ranked by hierarchical order reveals that a hierarchical structure is maintained but is dampened by the misalignments of traffic and intermodality with centralities (figure 8.17).

**Increasing Node Value**

In global cities with highly efficient transit networks, the centrality index is highest in the central part of the city. Zhengzhou could increase the hierarchy of stations along Line 3 by increasing the importance of central hubs and the number of lines and modes they connect and interconnecting neighboring stations into clusters.

Three planning approaches increase node values and thus the development potential of station areas:

- *Increasing the number of hubs and the number of lines and modes they connect in a dense network core.* Different network organizations shape land uses and land values differently. Networks that concentrate lines at focal points, interconnecting many lines and transportation modes, shape land prices and economic concentrations in a “spiky” way, with high peaks of value concentra-
tion. In contrast, a “flat” network—one that has no major hubs and no dense concentration of lines in a core—does not offer strong opportunities for capturing high land values around stations.

- **Interlinking neighboring stations into clusters.** An important property that enhances the connectivity of networks and the value of their nodes is clustering (establishing dense links between neighboring stations). This density of links creates many triangles between neighboring stations and tightly connects the network, offering passengers varied possibilities of interchange.

- **Increasing accessibility within the network.** Highly successful subway extensions (such as the addition of four lines in Seoul) cluster a large number of highly accessible stations in the network core, which concentrates density and economic activity.

### Coordinating Node Values with the Intensity of Land Use

The projected decentralization of people and jobs is likely to reduce the match between the centrality of subway stations and residential and job densities in station catchment areas. To reap the opportunities created by the network extension, planners could coordinate the intensity of land use and economic policies in three ways:

- Encourage development at major interchanges (highest degree centralities), at the most accessible stations of the network (highest closeness centrality), and at stations that are major articulations of the network (highest betweenness centrality).
- Moderate development in areas that are less accessible within the network.
- Discourage development in areas that are more than 1 kilometer from a subway station.

Zoning policies can be fine-tuned to coordinate transit infrastructure provision and land use development. FARs are an effective way to achieve optimal land use intensity. They should be set at different levels depending on uses and accessibility. Seoul set FARs as high as 10 for commercial uses around the most connected and central transit stations, at 2–4 for mixed residential and business areas, and at 1–2 for residential uses. Uses are defined with fine granularity, depending on proximity to and importance of transit stations (see box 1.8). FARs should include flexibility for transferring them between uses based on market changes, allowing the private sector to adjust the intensity of development to market needs.

### Place and Market Potential Value along Line 3

Zhengzhou’s planning is based on superblocks. Arterials over many subway routes are 60 meters wide; some are as wide as 100 meters (with additional setbacks). Street intersection densities (the number of intersections per square kilometer) around subway stations are low in new areas, as in most Chinese cities. Most superblock areas have fewer than 10 intersections per square kilometers—a fraction of the 80–100 recommended by UN-Habitat (2013). Street intersection density
reflects important properties of local accessibility to stations, the permeability and openness of the neighborhood, and the quality of the urban and social fabric. It is highly correlated with block size. Street lengths in Line 3 station areas are also well below the 18 kilometers of streets per square kilometer UN-Habitat recommends.

Place value for residents derives from vibrant, sustainable communities where they can access jobs, shopping, and services on foot or bicycle and enjoy a range of benefits, such as reduced transportation costs; easier access to amenities, including high-quality education; and improved public health. Like node value, it is unevenly distributed. In a typical city, many station areas are mainly residential, and a few are more job-oriented and mixed-use.

Walkability also differs across areas. It depends on street patterns and the design of streets as places for people. Street patterns determine not only whether residents and workers can access rail and bus transit but also whether they can access shopping, jobs, and services in their neighborhood. Street patterns with small blocks (about 100 meters per side) and high connectivity (no cul-de-sacs) enhance local accessibility. Superblocks and gating decrease accessibility.

**Place Value along Line 3**

The place value index is built from two subindexes: street intersection density and the diversity of land use. Diversity of land use is a measure of mixed use in the area surrounding the station. Each subindex was normalized (with 1 as the highest value). The composite index is the mean of the two subindexes.

The subindex of intersection density reveals low intersection densities almost everywhere along the line except in the city center, with a peak in the historical part of Shun Cheng Jie. Intersection densities are below 10 almost everywhere and as low as 6 in Dong Feng Lu and Hang Hai Dong Lu. The peak is 50, at Chung Cheng Jie, followed by 40 at Er Qi Guan Chang, but even these densities are low compared with the 80–100 recommended by UN-Habitat (2013). Diversity was estimated within a 1-kilometer area of each station (map 8.16) using a color analysis method applied to the regulatory plan color codes (see Shannon entropy in appendix B). Weak values capture large-scale mono-functional residential developments or warehouses in the eastern part of Zhengzhou; they have low street intersection densities. High values characterize more vibrant neighborhoods in the central part of the city. The western part of the city is more diversified than the newly developed eastern part, which is strictly zoned. As the diversity calculation is based on the regulatory plan, it tends to reflect expected future diversity rather than current use.

The interplay of land use and intersection densities and their discrepancies could guide public policies. Increasing land use diversity in the east should be accompanied by increasing street density and local connectivity.

The aggregated place value index maintains the pattern of higher place value in the historic central parts of the city, although the effect is dampened by planned land use (figure 8.19).
MAP 8.16 Land Use around Line 3 Stations

1. Xin Liu Lu  2. Sha Men Lu  3. Xin Long Pu Lu


(continued on next page)
MAP 8.16 Land Use around Line 3 Stations (continued)

16. Tong Tai Lu  17. Huang He Dong Lu  18. Nong Ye Dong Lu

Source: World Bank, based on data from the Zhengzhou City Planning.
FIGURE 8.18 Intersection and Land Use Diversity Subindexes of Line 3 Stations

Note: Stations are ordered from west to east.

FIGURE 8.19 Aggregated Place Value Index of Line 3 Stations

Note: Stations are ordered from west to east.
**Recommendations for Increasing Place Value**

Mixed-use development promotes a variety of compatible land uses and functions and provides a mix of residential, commercial, and community infrastructure in neighborhoods while reducing the demand for commuter travel. Transforming superblocks into communities with a better mix of uses, ensuring a wider ranging of building types and sizes, creating a finer mesh of streets with better connectivity, and building a better-defined and more vibrant public realm would increase place value in Zhengzhou.

**Market Potential Value along Line 3**

The market potential value index in this study is built from three subindexes that reflect the demand side of market potential value: human density, the job to resident ratio, and growth potential:

- Human density (the number of residents and jobs per square kilometer) is an indication of how economic potential and concentration of interaction and activity vary along the line.
- The jobs to residents ratio provides an indication of the level of economic monofunctionality of the station environment.\(^6\)
- Growth potential is the rate of growth of human density between 2009 and 2030. It is a proxy for market growth and market opportunities.\(^7\)

Each metric was normalized in a subindex (with 1 as the highest value). The composite index is the mean of the subindexes.

Human density around transit nodes in 2009 reveals a pattern of concentration within the centerwest quadrant (map 8.17). The subindex peaks at Shun Cheng Jie and Dong Da Jie (figure 8.20).

**MAP 8.17 Subindex 1: Human Density around Transit Stations in Zhengzhou, 2009**

The jobs to residents ratio indicates that the center-west quadrant has a better alignment of jobs around transit stations than the eastern part of the city (figure 8.21).

FIGURE 8.21 Subindex 2: Jobs to Residents Ratio around Line 3 Stations

Source: Urban Morphology and Complex Systems Institute 2016. Note: Stations are ordered from west to east.
The index of growth potential reveals a shift toward the east away from more central and more connected nodes (figure 8.22). The shift partly reflects development around the new high-speed rail station in Zhengzhou East.

Comparison of subindexes shows the contrast between 2009 and 2030 in terms of the human density and the jobs to residents ratio. Both indicators have well aligned values in 2009 that foster high market potential values. By 2030 the projected shift to the east as a result of the development of the HSR Zhengzhou East is projected to lead to a more spread out market potential (figure 8.23) across stations (figure 8.24). It does not peak strongly in the center and does not take off in the eastern part of the city.

**Recommendations for Increasing Market Potential Values**

The following strategies would foster TOD in the 800-meter radius around key stations, likely increasing their market potential value:

1. **Increase the density of people and jobs in key station areas.** The number of residents and workers in an area and the balance between jobs and the working-age population is correlated with the attractiveness of the area for residents and businesses and thus with the development of a strong real estate market. Such densification is particularly relevant in stations with high node values.
2. **Increase FARs around key stations.** In TOD projects, local authorities often raise FARs to facilitate densification and generate revenue streams that can be captured to finance infrastructures (transit and public spaces). Commercial FARs
FIGURE 8.23 Subindexes of Human Density, Job Resident Ratio, and Human Density Growth Potential around Line 3 Stations

Note: Stations are ordered from west to east.

FIGURE 8.24 Aggregated Market Potential Value Index around Line 3 Stations

Note: Stations are ordered from west to east.
around stations should be raised. Residential FARs could be raised, albeit at
lower than commercial FARs.

3. Increase the diversity of land parcel sizes to create a vibrant land market. Diversity of land parcel sizes can meet future demand and create an adaptive city. Urban development in China is based on 400 square meter superblocks, the current unit of land sales to developers. This contrasts sharply with the smaller unit of land sales found in other large cities outside China (see chapter 4). Smaller block size fosters an active land market with potential for mixed use.

**Interplay of Node, Place, and Market Potential Values**

By improving accessibility, improving the node value of a location creates conditions favorable to the further development of the location. Because of growing demand for transport, an increase in place value creates conditions favorable to the further development of the transport system.

Of the 21 Line 3 stations, only 2 have “high” place value (figure 8.25). (These values are relative. The medium values are low by international standards, as most

**FIGURE 8.25 Relationship between Node and Place Values around Line 3 Stations**

of the station surroundings are based on superblocks with low intersection density, leading to reduced accessibility to stations.) Er Qi Guang Chang stands out as a place of high value and high potential in terms of node value, connectivity, and diversity. Zhong Zhou Da Dao, Huang He Lu, and Dong Da Jie Da Jie stand out in terms of node value; their medium place value should be enhanced.

Figure 8.26 reveals strong imbalances between market potential and node values. Er Qi Guang Chang stands out in terms of both values. Most market potential value is moderate, with little alignment with node value. Stations with higher node values have lower market potential values than stations with lower node value on the periphery of the network. This pattern is the likely result of decentralization policies that do not align land use intensity and transport and may not let the market shape the distribution of densities based on accessibility. Growth should occur as a priority in more connected stations (below the 45-degree line) rather than in less connected stations (above the 45-degree line) requiring planners to think about alternative spatial scenarios of growth.

The relationship between market potential and place value shows the same type of imbalance (figure 8.27). Er Qi Guang Chang and Shun Cheng Jie stand out in

**FIGURE 8.26 Relationship between Market Potential and Node Values around Line 3 Stations**

![Graph showing the relationship between market potential and node values](image)

Transforming the Urban Space

terms of place value but remain below their potential in terms of market potential value, because planning does not incentivize development around these stations.

**Recommendations**

A functional and cost-effective transit infrastructure—one that gets commuters to and from work efficiently—is a fundamental prerequisite of a thriving business environment in a large city. Another is a set of economic and housing policies that match transit accessibility, jobs, and housing and clusters companies in places accessible by large numbers of people, in order to broaden the choice of affordable housing locations.

The 3V Framework helps planners meet these two prerequisites by allowing them to prioritize investments and adjust policies and regulatory planning in order to intensify development around the highest potential stations and to define strategies in diverse economic and urban contexts. TOD can unlock a new wave of urban productivity in Zhengzhou if land use policies that encourage higher densities of jobs and people in areas with good transit accessibility are put in place. This

integrated planning approach would involve a shift to more compact, connected, and coordinated urban growth, with land development intensities aligned with transit networks accessibility.

**Creating Transit-Oriented Districts Near the Center**

The urban core is the most efficient place for concentrating jobs; doing so fosters agglomeration and localization economies. Dispersing economic growth to the periphery creates inefficiencies, because networks cost more per capita at the periphery and economic output per capita and per serviced land decreases when development occurs far away from the urban core (Salat 2016).

Fostering growth at the center requires appropriate regulations for block size, FARs, and coverage ratios. TOD zoning at the Zhengzhou master plan level could establish a minimum density for jobs and housing for the station catchment area. The regulatory plan could support the redesign of TOD communities by:

- creating a more walkable street network, with denser and more connected street patterns (80–100 intersections per square kilometer), narrower streets, reduced or eliminated setbacks, and streetscapes designed for people
- establishing urban design standards at the small block rather than the super-block level
- fostering mixed-use districts that are walkable and bikable, with transit-oriented street and circulation systems and high densities of population and jobs. Within these districts, areas close to major transit stations would have higher densities and land-use standards, allowing the municipality to capture some of the value of the investment in transit infrastructure.

**Adopting Different Strategies for Different Types of Stations**

The 3V Framework allows policy makers to assess the development potential of station areas in a proactive and dynamic way. All nodes in a network are not equal. Node and place values are unevenly distributed across Zhengzhou and along Line 3. Some stations, such as Er Qi Guang Chang, score high in node and place value. International experience suggests that such stations could play a major role in fostering economic and job concentration and commercial real estate development.

The imbalances between values create development opportunities. At many stations, the supply of new infrastructure is stronger than the activity of land use; there is potential to enhance place value to derive market value from the current oversupply of connecting infrastructure. At other stations, greater connectivity will encourage economic activity and increase market potential value.

The 3V analysis identifies which type of development is more appropriate in a station area and which stations have the highest development and value capture potential. It helps define station types based on node, place, and market potential values. Zhengzhou’s policy makers can use the framework to (a) build a typology of stations that classifies them into subgroups for applying different development
strategies and (b) identify the imbalances between connectivity, accessibility, place quality, and market potential values at stations. Identification of such imbalances enables the relevant land, economic development, and transport agencies to develop multiagency solutions.

**Capturing Value**

Increases in connectivity and accessibility will increase land value in subway catchment areas. This value can be captured to create a positive feedback loop for financing infrastructure, enhancing the public realm, and building inclusionary housing (see chapter 3).

**Notes**

1. This chapter is based on projections made as part of the traffic modeling for Line 3 of the Zhengzhou subway (for which the World Bank provides part of the financing); the Zhengzhou master plan; detailed control plans with land use, floor area, coverage ratios, 3D renderings of the urban fabric, technical specifications of station designs; population and jobs data by census tracts and within the polygons of the traffic study and forecasts for 2020 and 2030; and GDP data by subdistrict. It benefitted from discussions with Zhengzhou planning bureau and transportation bureau and from field visits to each of the 21 sites of the planned stations.

2. The FAR (also known as floor space ratio [FSR], floor space index [FSI]) is the ratio of a building’s total floor area (gross floor area) to the size of the piece of land upon which it is built.

3. Calculated as:

\[
\frac{\sum_{\text{location}} \left( \frac{\text{number of jobs accessible from each location}}{\text{total jobs in the city}} \times \frac{\text{population in each location}}{\text{Total Population}} \right)}{100}\%
\]

4. Ridership is aligned but not directly correlated with structural properties of the network (correlation was tested). It is thus valid to keep the traffic and centralities as separate subindexes for building the centrality index.

5. In more complex networks with high-ranking hubs, such as London and Tokyo’s, weighting could give higher weight to degree centrality.

6. The maximum value of the subindex is 1. As some places (industrial zones) have more than 1 job per resident and others (residential neighborhoods) have far less than 1 job per resident, the subindex was normalized between 0 and 1 with a lognormal function in order to give values below 1 to mono-functional neighborhoods (either excessively job or resident oriented).

7. This value was normalized between 0 and 1 with a log function calibrated to have 0.5 for zero growth, values below 0.5 for decreases in density, and 1 for a 200 percent increase, with a cut-off beyond 200 percent.
References


Li, Qu, Gerald Ollivier, Holly Krambeck, and Tatiana Peralta. 2016. Using Travel Time-Based Analysis to Evaluate the Potential Impact of Transit Oriented Development on Job Accessibility. World Bank, Washington, DC.


Cities that effectively integrate transportation and land use reduce traffic congestion, promote business, improve public services, and boost revenues. Such cities are more livable, economically competitive, and environmentally and socially sustainable than other cities.

Transit-oriented development (TOD) contributes to shaping urban forms in order to increase access to transit and access to jobs by transit. Managed well, it can unlock land for affordable housing and more inclusive urban growth by reducing the burden of transportation costs on poor, low and middle income households.

Cities that grow efficiently around transit lines—such as Tokyo, Singapore, Hong Kong SAR, China, London, and New York—are strategically planned with a long-term vision of the evolution of their spatial structure. This vision factors in long-term population and economic growth. It is turned into master plans with 15- to 20-year horizons that are reviewed every 5 years. These master plans detail land use with a high level of granularity, setting variable intensities of development and allocation of uses at the scale of small urban blocks of about one hectare. They have built-in flexibility in zoning codes and incentives that allow some variation to planning and design parameters. Land supply is planned in tandem with market demand and cycles.

The 3V Framework helps policy makers integrate transport planning and land use across different geographical scales, from metropolitan to local. It helps identify areas of opportunity where the combination of high connectivity and the potential for redevelopment and regeneration of the urban (and in some cases social) fabric will generate market response from the private sector, initiating a positive feedback loop of local urban growth and value capture finance. It is applicable not only to areas with the highest growth potential but also to areas with less potential but more land opportunities. As the case studies demonstrate, by creating and capturing higher land values around urban transit stations and corridors, cities can recoup some of the costs of building, operating, and maintaining mass transit systems, as well as support TOD in ways that make them more appealing places to live, work, and do business.

The methodology includes an analysis of transit networks. It integrates market demand and supply analysis with more traditional node/place models. Consideration of market response is essential for transitioning toward more sustainable urban growth, particularly in rapidly growing cities, where the integration of the space economy is crucial for economic success.
The 3V Framework is an instrument for tailoring, with a high granularity, intensities of development to different levels of transit accessibility and to different local contexts. It acknowledges the wide variations in densities of jobs and residents and in accessibility across the urban space. It comprises both a vision of the metropolitan urban shape that is most efficient for inclusive economic growth and actionable differentiated local strategies for specific development around transit stations. As such, it is particularly well adapted to contribute to integrated planning that articulates a long-term vision and local plans and integrating transportation infrastructure investment and land use planning.

Above all, the 3V Framework is a tool for developing options for rapidly growing cities. The World Bank plans to apply it in various contexts, including India and Latin America. The Framework is not limited to investments in subway networks; it can be applied to other kinds of mass transit networks, such as bus rapid transit.

Implementing the framework involves a long-term strategic vision and a process of actions and investments. The process should be able to adapt to the dynamic, evolving, and complex nature of cities and be able to continuously update the vision, as required by changing conditions and market response.

This shared vision—and the engagement of multiple stakeholders in its implementation—drive spatial, social, and economic transformation. Key to success is coordinating across scales and sectors, integrating a multiplicity of actions and initiatives that will reinforce one another, implementing the vision with milestones and indicators, and being highly granular and contextual.
Network science has discovered that networks (neural networks, natural networks, transit networks, the Internet) have a strict architecture that is captured by a few simple mathematical regularities (inverse power laws). These formulas represent a novel perspective from which to understand the interconnected urban world and the relationship between transit network layouts and people, jobs, and economic concentrations.

Urban values such as the ones used in the 3V Framework are not distributed evenly or randomly through urban space but according to identifiable mathematical patterns. The 3V Framework is not just an empirical method; it derives policy making from the underlying order of urban space and urban connectivity, as described below.

Power Laws in the Distribution of Values across Urban Space

Inverse power laws govern demographic densities in cities.¹ Research by the Urban Morphology and Complex Systems Institute (Salat 2016, 2017) documents the presence of power laws at the intra-urban scale, where they order the patterns of most urban values and their distribution across urban space. An inverse power law distribution does not have a central peak, like the familiar bell curves found in statistics. It is a continuously decreasing curve, indicating that many small observations coexist with a few large ones in a highly structured mathematical way that relates the large, the intermediate, and the small (figure A.1). This relationship characterizes variables such as density, centrality, connectivity, and accessibility.

In a city, for example, the density of jobs is high in a few locations, medium in a moderate number of locations, and low in a large number of locations. The frequency of a component of size $x$ is proportional to the inverse of its size at an exponent $m$ characteristic of the system. The relative frequency of each type is determined by the mathematics of the rank size distribution: the size of any urban
Inverse power laws are a measure of inequality or hierarchy in systems (Pumain 2005). They were first introduced in economics by Vilfredo Pareto (1906). The Pareto distribution is a power law probability distribution that is used to describe social, scientific, geophysical, actuarial, and many other types of phenomena. Pareto originally used it to describe the allocation of wealth in society, where a small proportion of the population owns a large portion of wealth. He also used it to describe the distribution of income.

The Pareto distribution can be observed in GDP density across urban space: The same spatial distribution of GDP characterizes both London and Zhengzhou, despite huge differences in their socioeconomic structures. An inverse power law of exponent $-0.90$ characterizes both, indicating a high level of concentration of GDP in a few areas. The distributions of jobs is similar in Paris, London, and New York (with exponents of $-1.0$). In contrast, the exponent is $-0.89$ in Zhengzhou and $-0.94$ in Shanghai, reflecting decentralizing policies.

This idea is sometimes expressed more simply as the Pareto principle or the 80–20 rule, which says that 20 percent of the population controls 80 percent of the wealth. In terms of urban space, it means that 20 percent of urban land produces 80 percent of urban GDP. This pattern explains the economic break-up point of sprawling: When a city expands at low density, infrastructure costs for servicing the land remain high per capita while the contribution to urban GDP becomes negligible (Salat 2016; Salat, Bourdic, and Kamiya 2017).

Recent research shows that inverse power laws govern the distribution of degree and closeness centralities in transit networks; GDP; densities of jobs, people, and amenities; energy intensity (energy used per unit of urban land) and productivity (gross value added created per unit of energy used); as well as many other ur-
ban characteristics (Salat 2017). The ubiquity of power laws in urban space derives from power laws in networks. Cities can be described as networks from which locations emerge.

**Power Laws in Network Centralities and Commuting Flows**

This section looks at properties of subway networks and commuting flows that underlie the clustering of stations based on their node values from a graphs theory perspective (see Barabasi and Albert 1999 and Barabasi 2005).

**Power Laws in the Core-and-Branches Structure of Subway Networks**

Efficient subway layouts in global cities appear to converge toward a similar layout (Roth and others 2012). The structure of the world’s largest subway networks—including Beijing, Shanghai, Tokyo, Seoul, London, Paris, and New York—share similar generic features despite these cities’ geographical and economic differences. This shape is made of a core with branches radiating from it. Densely interconnected by crisscrossing lines, the core has a spatial extension of about five kilometers, because it would be too costly to maintain a high density of stations beyond this radius. Beyond this radius are (lower-density) branches. The density of stations with distance to the city center sharply decreases and follows an inverse power law of the form $R^{-1.6}$, where $R$ stands for radius. For most networks, the average number of links per station within the core is about 2.5, and at least 60 percent of stations at the core serve at least two lines. In all the studied subways, the number of stations grows by a factor of $R^2$ at the core. Beyond the core the density of stations decreases very quickly with distance from the core, with the number of stations growing at only $R^{0.5}$.

**Power Laws in the Distribution of Centrality Values**

In graph theory and network analysis, indicators of centrality identify the most important vertices within a system. Applications include identifying the most influential people in a social network, key infrastructure nodes in the Internet or urban networks, and superspreaders of disease.³

Centrality indices are answers to the question “What characterizes an important vertex?” For mass transit networks, degree centrality, closeness centrality, and betweenness centrality best capture the centrality of stations.

**Degree centrality**

Historically first and conceptually simplest is degree centrality, defined as the number of links at a node. Hubs dominate the structure of all networks in which they are present. They create short paths between any two nodes in the system.

In most networks, most nodes have only a few links, and a few big hubs have a very large number of links. The links connecting the smaller nodes are not sufficient
to ensure that the network is fully connected. It is the large hubs that make networks work.

Once the Grand Paris Express is built, the Paris metro will have a few hubs in the hypercore of the network with many connections, including four stations with six or more connections (figure A.2). These stations will be located in parts of the city where one third of jobs are agglomerated. The system will also have a long tail of single-line stations (degree centrality of 2).

**Closeness centrality**

The farness of a node $x$ is defined as the sum of its distances from all other nodes; its closeness is defined as the reciprocal of its farness. The more central a node is, the shorter its total distance from all other nodes.

Stations in the network core in Paris are closer to other stations than are stations outside the core (figure A.3). Closeness centrality decreases linearly, not according to an inverse power law.

**Betweenness centrality**

Betweenness centrality quantifies the number of times a node acts as a bridge along the shortest path between two other nodes. It was introduced as a measure for quantifying the control of one person over communication between other people in a social network. Vertices that have a high probability of occurring on a randomly chosen shortest path between two randomly chosen vertices have a high level of betweenness.
A subway station with high betweenness centrality has significant influence on the transfer of passengers through the network (assuming that passengers follow the shortest paths). These stations areas have high development potential, as demonstrated by stations along Tokyo’s Yamanote Line.

**FIGURE A.3** Closeness Centrality of Paris Subway Stations in 2015


Note: Figures reflect centrality after the opening of the 67 new stations and 200 kilometers of new lines of the Grand Paris Express.

**FIGURE A.4** Betweenness Centrality of Paris Subway Stations in 2015


Note: Figures reflect centrality after the opening of the 67 new stations and 200 kilometers of new lines of the Grand Paris Express.
As in London, New York, and Tokyo, the distribution of betweenness centralities in Paris follows an inverse power law of exponent –1 (figure A.4), suggesting a universality class (a collection of mathematical models that share a single scale invariant limit). Although cities may differ dramatically at small scales, their behavior becomes increasingly similar as the limit scale is approached. In particular, asymptotic phenomena such as critical exponents will be the same for all cities in the class (notably for the density distribution of jobs and the betweenness centralities of their subway networks).

Box A.1 illustrates the relationships between betweenness centrality in urban rail networks and local urban growth in London.

**BOX A.1 Promoting Urban Growth through Transit: London’s Circle Line**

The 1846 Royal Commission on Railway Termini prevented trains from entering Central London (an area of about 32 square kilometers). The result was a ring of disconnected stations, which stimulated a market for interconnections and the development of the underground. Surface rail and underground networks expanded together, producing both competition and a high degree of complementarity between the two modes.

From the linkage between the train stations, the Circle Line was born, in 1884. Before December 13, 2009, Circle Line trains travelled in both directions around a simple loop with 27 stations and 20.75 kilometers.

Box map A.1.1 shows the route of the Circle Line since December 13, 2009 and the London boroughs it serves. The line serves the highest concentration of wealth in Europe. Its 27 kilometers serve...
BOX A.1 Promoting Urban Growth through Transit: London’s Circle Line
(continued)

36 stations, including most of London’s main line railway terminals. Most of the route and all of the stations are shared with the District, Hammersmith & City, and Metropolitan lines. The Circle Line and the Hammersmith & City line combined host more than 114 million passenger journeys a year.

The hierarchy of betweenness centrality in London follows an inverse power law of exponent – 1.15. The Circle Line has the highest peaks of betweenness centrality in London (box map A.1.2). This network layout created strong hubs, which became high peaks of economic density, job concentration, and land and property values. The evolution of London’s public transportation network shaped the spatial and economic growth of the urban region, with a strong concentration in the center, along a ring of highly connective transfer hubs.

BOX MAP A.1.2 Betweenness Centrality of London Subway Stations in 2015

Source: © Urban Morphology and Complex Systems Institute. Used with the permission of UMCSI. Further permission required for reuse.

(continued on next page)
Transforming the Urban Space

Power Laws in the Distribution of Commuting Flows

Research by the Urban Morphology and Complex Systems Institute (Salat and Bourdic 2015) shows that ridership per station in Paris and London and the structure of commuting flows follow the same mathematical distribution. Power laws also describe passenger flows and the intensity of commuting routes. Traffic in London’s tube stations in 2010 follows an inverse power law of exponent \(-1\), with a concentration of traffic in highly connective hubs corresponding to the train stations.

The distribution of the number of commutes per commuting line (all modes considered) between home and work in Paris (map A.1) reveals an inverse power law of exponent \(-0.65\) (figure A.6).

**BOX A.1 Promoting Urban Growth through Transit: London’s Circle Line**

(continued)

Box figure A.1.1 shows the hierarchy of connectivity along the Circle Line. The higher exponent on the Circle Line (0.58) than on the London system as a whole (0.31) shows that inequality between hubs is more intense at the core of the subway system, where high connectivity is concentrated.

The Circle Line is extremely well connected. It will become even better connected after the opening, in 2018/2019, of Crossrail 1. In the longer term, High-Speed 2 (HS2) is expected to transform Euston and King’s Cross-St Pancras into the United Kingdom’s largest mega rail hub, as rail passengers will be able to interchange between HS2 and Crossrail 2 (under consideration) at Euston. This intensity of connectivity offers excellent opportunities for urban development around train stations.

**BOX FIGURE A.1.1 Degree Centrality along the Circle Line in 2015**

![Graph showing degree centrality along the Circle Line in 2015](image)


Note: Figure includes loop-only and transfers to train stations.
FIGURE A.5 Distribution of Traffic Volume at London Subway Stations


MAP A.1 Number of Commutes per Commuting Line in Paris

Notes


2 Empirical data show that 67 percent of London’s GDP is produced in 20 percent of London’s area. In contrast, 80 percent of Zhengzhou’s GDP is produced in 20 percent of Zhengzhou’s area. The difference comes not from the distribution, which is identical, but from the size of the cities. The long tail of low values of GDP per square kilometer at the urban periphery makes a weak contribution to the GDP. Thus, if the city expands, the proportion of its urban land that does not contribute significantly to its GDP will expand accordingly and GDP will appear more concentrated in the simplified version of the Pareto principle. Only the complete Pareto description, with the exponent of the power law, captures the distribution. It reveals striking structural similarities different cities.

3 Centrality concepts were first developed in social network analysis; many of the terms used to measure centrality reflect their sociological origin.

References


Appendix B Subindexes for Estimating Node, Place, and Market Potential Value of Stations

Table B.1 summarizes the key subindexes that can be used to estimate the node, place, and market potential values of stations. Selection of subindexes, particularly for market potential value, depends in part on the availability of data. All subindexes are normalized to a 0–1 scale, as shown in the example of Zhengzhou (see chapter 8).

### TABLE B.1 Subindexes for Estimating Potential Node, Place, and Market Value of Stations

<table>
<thead>
<tr>
<th>Type of value/subindex</th>
<th>Measure</th>
<th>How to calculate</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Node</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subindex 1.1: Degree centrality</td>
<td>Number of mass transit links at a station</td>
<td>Calculated at the network level using graph analysis software. Each direction counts as a link.</td>
<td>London (see map 2.1)</td>
</tr>
<tr>
<td>Subindex 1.2: Closeness centrality</td>
<td>Average distance (in terms of number of links) from a station to every other station in the network</td>
<td>Calculated at the network level using graph analysis software. Measured by dividing 1 by the average shortest path from a station to all other stations in the network.</td>
<td>London (see map 2.2), Zhengzhou (see figure 8.10)</td>
</tr>
<tr>
<td>Subindex 1.3: Betweenness centrality</td>
<td>Extent to which a transit node is located at the crossroads of the public transport network</td>
<td>Calculated at the network level using graph analysis software. Calculated as: [ \text{betweenness}<em>{node} = \sum</em>{k} \frac{\sigma_{j}(k)}{\sigma_{ij}} ] where ( \sigma_{j} ) is the total number of shortest paths from node ( i ) to ( j ) and ( \sigma_{ij}(k) ) is the number of those paths that pass through station ( k ).</td>
<td>London (see map 2.3), Zhengzhou (see figure 8.12)</td>
</tr>
</tbody>
</table>

Subindexes 1.1–1.3 are combined into a single (weighted-average) centrality index.

| Subindex 1.4: Daily ridership | Strength of flows of traffic in a node | Daily number of passengers entering a station, excluding passengers not stopping. | Zhengzhou (see figure 8.8) |

(continued on next page)
### TABLE B.1 Subindexes for Estimating Potential Node, Place, and Market Value of Stations (continued)

<table>
<thead>
<tr>
<th>Type of value/subindex</th>
<th>Measure</th>
<th>How to calculate</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subindex 1.5: Intermodal Diversity</td>
<td>Number of complementary transit modes connecting to a station</td>
<td>Number of lines of different transit modes accessible within walking distance of a station.</td>
<td>Zhengzhou (see figure 8.15)</td>
</tr>
</tbody>
</table>

The centrality subindex, subindexes 1.4 and 1.5, are combined into a single (weighted-average) node value.

### Place

**Subindex 2.1: Density of street intersections**  
Number of intersections per square kilometers within an 800-meter radius of each transit station  
Calculated through street GIS shapefiles/software, such as ArcGIS or QGIS on an area with an 800-meter radius centered on the station or on a square measuring 800 x 800 meters centered on the station.  
Zhengzhou (see figure 8.18); example 1 below

**Subindex 2.2: Local pedestrian accessibility**  
Proportion of a an area of 800-meter radius around a station that is actually reachable in a 10-minute walk  
Calculated using open sources software Open Trip Planner Analyst and OpenStreetMap to determine the proportion of the 800-meter radius around the station that is reachable by foot within 10 minutes.  
Example 2 below

**Subindex 2.3: Diversity of uses**  
Number of types of land use in a dataset  
Calculated using the Shannon entropy formula:  
\[
\text{Entropy} = -\sum_{i=1}^{N} \frac{p_i}{p_N} \log \left( \frac{p_i}{p_N} \right)
\]

where \(i\) is the type of use (commercial, community, residential, industrial); \(N\) is the number of uses; \(p_i\) is the area dedicated to use \(i\); and \(p_N\) is the area of the cell dedicated to any use. The value of a diversity index increases when the number of types increases and evenness increases. For a given number of types, the value of a diversity index is maximized when all types are equally abundant.  
Zhengzhou (see figure 8.18)

**Subindex 2.4: Density of social infrastructure within 800 meters of the station**  
Number of cultural, educational, and health services within a radius of 800 meters from the station  
Calculated by dividing the number of social infrastructure facilities within 800 meters of a station. Georeferenced points of interest are increasingly collected in cities and can be used as a basis for such calculation.  
The four place subindexes are combined into a single (weighted-average) place value.

### Market potential

**Demand**

**Subindex 3.1: Human density**  
Number of people and jobs per square kilometer around the transit station within a catchment area of 800-meter radius  
Calculated based on population and job data available through census or transport model developed for metro lines.  
Zhengzhou (see figure 8.20); Paris (see example 3 below)
### TABLE B.1 Subindexes for Estimating Potential Node, Place, and Market Value of Stations

<table>
<thead>
<tr>
<th>Type of value/subindex</th>
<th>Measure</th>
<th>How to calculate</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subindex 3.2: Jobs/residents ratio</td>
<td>Jobs/residents ratio within 800-meter radius of each station</td>
<td>Calculated based on population and job data available through census or transport model developed for metro lines.</td>
<td>London; Zhengzhou (see figure 8.21)</td>
</tr>
<tr>
<td>Subindex 3.3: Human density growth potential</td>
<td>Forecasted rate of population and job growth over 10–20 years within 800-meter radius of each station</td>
<td>Calculated based on population and job data available through census or transport model developed for metro lines.</td>
<td>Zhengzhou (see figure 8.22)</td>
</tr>
</tbody>
</table>

The three demand subindexes are combined into a single (weighted-average) market potential value if other subindexes are not available.

| Subindex 3.4.1 Social composition of the neighborhood | Average or median income | Calculated based on population data available through census or transport model developed for metro lines. | Paris (see example 4 below) |
| Subindex 3.4.2: Social composition of the neighborhood | Percentage of managers in labor force | Calculated based on population data available through census. | Paris (see example 4 below) |

| Subindex 3.5: Number of accessible jobs by transit | Number of accessible jobs within 30 minutes by public transit and foot | Calculated with open source software Open Trip Planner Analyst based on population data available through census or transport model developed for metro lines. | |

#### Supply

| Subindex 3.6: Real estate opportunities | Developable land and developable floor space around each subway station within a radius of 500 meters for the highest market premium and between 500 meters and 1 kilometer for the lower market premium | Calculated by comparing GIS map of built densities with a map of regulatory floor area ratio (FAR) and by subtracting existing built floor space from maximum floor space that can be built within the regulatory FAR. | Singapore (see example 5 below) |

#### Market vibrancy

| Subindex 3.7: Dynamics of real estate development | Additional square meters built around stations during past decade | Obtained from local public planning agencies or agencies monitoring real estate activity | Paris (see example 6 below) |
Example 1 Density of Street Intersections

Connected street patterns with a high density of street intersections promote accessibility and walkability. UN-Habitat recommends a density of at least 80–100 intersections per square kilometer. A high density of intersections is also a good proxy for block size. Small block sizes (about 100-meter sides) with vibrant edges (facades on the perimeter with businesses) promote more compact development and walkability. The higher the density of intersections, the smaller the blocks are. This indicator captures block size, the “granularity” of the urban fabric, the diversity of paths around the transit station, and local accessibility. Map B.1 shows examples of street intersection density for squares measuring 800 x 800 meters.

**MAP B.1 Number of Street Intersections per Square Kilometer in Selected Cities**

Venice: 688  
Toledo: 420  
Florence: 255  
Turin: 191  

London Mayfair 1735:165  
Paris Etoile: 133  
Barcelona Cerda plan: 103  
Amsterdam 17th century:195  

Brasilia Quadra: 41  
Manhattan: 120  
Washington suburbs: 48  
Washington L’Enfant plan:36  

Beijing South: 16  
Beijing South: 13  
Shanghai Liangyang Towers: 27  
Shanghai Lujiazui (Pudong): 17  

Source: Salat, with Labbé and Nowacki 2011. © Serge Salat. Used with permission of Serge Salat. Further permission required for reuse.
Example 2 Local Pedestrian Accessibility

An isochrone is a curve that shows equal travel times. Isochrones are critical because how long it takes to get somewhere is more relevant than how far away it is. Isochrones have been used for more than 130 years in science and transport planning to understand the relationship between movement and time. Isochrone maps can include a combination of transport modes or focus on just one mode.

Walking isochrones map walkable catchments or “pedsheds.” They provide insight into the permeability of a neighborhood, as well as an understanding of accessibility to public transport, jobs, and services.

Map B.2 illustrates how superblocks reduce accessibility around subway stations in Tianjin, a major port city in northeastern China. The green circle displays the theoretical maximum accessibility within an 800-meter radius. Because of superblocks, only 50–65 percent of the 800-meter radius area is accessible by foot. The Liu Yuan Station area has 4.4 kilometers of streets per square kilometer, far below the minimum length of 18 recommended by UN-Habitat; within an 800-meter radius circle, the average block surface is 103,300 square meters, and the density of intersections is 7. This density is just 1/11th–1/15th the density recommended by UN-Habitat and international best practice. The Golden Triangle Station area, the most accessible and permeable station in Tianjin, has a street density of 11.2 per square kilometer; within an 800-meter radius circle, the average block surface is 22,400 square meters and the density of intersections is 48. The Tu Cheng Station area has a linear density of 5.8 per square kilometers; within an 800-meter radius, the average block surface is 74,250 square meters, and the density of intersections is 9.

The subindex measures the percentage of the 800-meter radius area that can be reached within a 10-minute walk (area in green).

MAP B.2 Ten-Minute Walk Isochrones within 800-Meter Radius of Three Subway Stations in Tianjin, China

Note: Red: Accessibility at 200 meters. Yellow: Accessibility at 400 meters. Green: Accessibility at 800 meters. The green area is used to measure the subindex.
Example 3 Human Densities

Human density along the subway lines that will be built as part of the Grand Paris Express varies by a factor of more than 10, from less than 5,000 to more than 50,000 (map B.3).

MAP B.3 Estimated Human Densities (People + Jobs) along Planned Grand Paris Express Stations

Source: Salat and Bourdic 2015. © Urban Morphology and Complex Systems Institute. Used with the permission of UMCSII. Further permission required for reuse. Data from INSEE.
Example 4 Median Incomes

Map B.4 shows median incomes per unit of consumption (a measure used by the Organisation for Economic Co-operation and Development [OECD] to reflect the composition of households) along the new subway lines being built as part of the Grand Paris Express. It shows lower values in the northeast quadrant.

MAP B.4 Estimated Median Income per Unit of Consumption along Planned Grand Paris Express Stations, 2011

Source: Salat and Bourdic 2015. © Urban Morphology and Complex Systems Institute. Used with the permission of UMCSII. Further permission required for reuse. Data from INSEE.
Example 5 Percentage of Managers

Map B.5 shows the percentage of managers in the labor force along the subway lines being built as part of the Grand Paris Express. It shows a strong concentration of managers in the west, near the core of the historic city (Paris intra-muros). Multicriteria analysis by Salat and Bourdic (2015) shows that these areas have the highest market potential.

Source: Salat and Bourdic 2015. © Urban Morphology and Complex Systems Institute. Used with permission of UMCSII. Further permission required for reuse. Data from INSEE.
Example 6 Floor Area Ratios

Table B.2 presents the ranges of FARs applied in various cities. Based on those ratios, the potential for development can be estimated.

Map B.6 presents FARs along Singapore’s Orchard Road. FARs in Singapore along Orchard Road, one of Singapore main commercial roads, are set higher (4.2–5.6) close to subway stations and are zoned for commercial uses (in dark blue) and offices (in violet) on small blocks; 100 meters away from the transit line, FARs are lower (1.4–2.8). Some blocks in light blue are residential and commercial with FARs of 4.2–5.6.

TABLE B.2 Floor Area Ratios by Type of Land Use in Selected Cities

<table>
<thead>
<tr>
<th></th>
<th>Tokyo</th>
<th>Hongkong</th>
<th>Singapore</th>
<th>New York</th>
<th>Seoul</th>
<th>average</th>
<th>average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>min.</td>
<td>max.</td>
<td>min.</td>
<td>max.</td>
<td>min.</td>
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MAP B.6 Floor Area Ratios along Singapore’s Orchard Road

Source: Bertaud 2008. © Alain Bertaud. Used with permission from Alain Bertaud. Further permission required for reuse.
Example 7 Dynamics of Real Estate Development

Map B.7 shows the market dynamism of Paris’s northwest quadrant. It lies in contrast to the lagging eastern part of the city.

MAP B.7 Increase in Construction Programs between 2000 and 2012 around Planned Grand Paris Express Subway Stations

Source: Salat and Bourdic 2015 © Urban Morphology and Complex Systems Institute. Used with the permission of UMCSII. Further permission required for reuse. Data from Atelier Parisien d’Urbanisme (APUR) and Direction Régionale et Interdépartementale de l’Equipement et de l’Aménagement d’Ile de France (DRIEA).

References


Imagine a city that is more competitive, with higher-quality neighborhoods, lower infrastructure costs, and lower CO2 emissions per unit of activity. This city has lower combined transportation and housing costs for its residents than other cities at similar levels of economic activity. Its residents can access most jobs and services easily through a combination of low-cost public transport, walking, and cycling. Its core economic and population centers are resilient to natural hazards. It is able to finance improvements to public space, connectivity, and social housing by capturing value created through integrated land use and transport planning. Such a vision has never been more relevant for rapidly growing cities than it is today. Transit-oriented development (TOD) can play a major role in achieving such a vision.

Based on an observation of methodologies applied in different countries, the World Bank’s Community of Practice on Transit Oriented Development has developed a methodology called the 3 Value (3V) Framework, which outlines a typology to facilitate TOD implementation at the metropolitan and urban scale in various contexts. The 3V Framework equips policy and decision makers with quantified indicators to better understand the interplay between the economic vision for the city, its land use and mass transit network, and urban qualities and market vibrancy around its mass transit stations.

This book provides examples of approaches taken by cities like London and New York to align their economic, land use and transport planning to generate jobs and high value. We hope the book will help readers develop a coherent vision, policies, and strategy to leverage the value created through enhanced connectivity and accessibility and make cities even more appealing places to live, work, play, and do business.

MDTF Sustainable Urbanization
China World Bank Group Partnership Facility
TRANSFORMING THE URBAN SPACE THROUGH TRANSIT-ORIENTED DEVELOPMENT (TOD)

Through the interplay of Place, Node and Market potential values around mass transit stations.

TRANSIT-ORIENTED DEVELOPMENT (TOD) FOSTERS SUSTAINABLE URBAN GROWTH

- Reduces greenhouse gas emissions
- Improves resilience to natural hazards
- Enhances mobility and higher access to jobs
- Increases competitiveness through agglomeration effects
- Increases and concentrates real estate value in the best connected areas
TOD SHAPES URBAN STRATEGIES AT DIFFERENT SCALES:

**METRO SCALE**
Maximize job accessibility citywide through integrated transit while ensuring local accessibility to health, education and amenities.

**NETWORK SCALE**
Concentrate development around well connected stations.

**STATION SCALE**
Create diverse and vibrant urban communities, applying good design.

---

EIGHT KEY PRINCIPLES TO PLAN TOD CITIES

- Align human and economic densities based on mass transit characteristics for greater accessibility
- Create vibrant, people-centric public spaces around mass transit stations
- Create compact regions with short commutes
- Develop neighborhoods that promote walking and cycling
- Ensure resilience of areas connected by mass transit
- Develop good quality, accessible and integrated public transit
- Plan and zone for mixed use and mixed income neighborhoods at a corridor level
- Manage private vehicle demand
Densities of jobs and residence vary widely across the urban space - with a concentration of jobs and housing in areas of high accessibility.

Understanding where, when and how economic value can be created requires a typology. Three values underpin such a typology:

**Node Value**
Importance of a station in the public transit network derived from its passenger traffic volume, inter-modality, and centrality within the network.

**Place Value**
Urban quality and diversity of a place and its attractiveness to residents in terms of amenities, facilities and local accessibility to daily needs created by mixed land use patterns and urban design.

**Market Potential Value**
Unrealized market value of station areas considering major drivers of demand such as resident and job densities, accessibility by transit and land market dynamics.
THE 3 VALUE (3V) FRAMEWORK OFFERS AN APPROACH TO:

- Provide a quantified basis for understanding development opportunities around mass transit stations based on their place, node and market potential value.
- Achieve shared development vision with citizens, private developers, investors, financiers, companies and other stakeholders.
- Facilitate a dialogue among agencies to identify imbalances between connectivity, place quality and market potential values.

HOW TO INCREASE THE THREE VALUES

**NODE VALUE**
- Increase number of hubs and number of lines/modes they connect to
- Interlink neighboring stations into clusters
- Increase accessibility within the network for all

**PLACE VALUE**
- Increase compactness
- Allow different use of different floors
- Increase concentration of commercial, cultural and education amenities
- Design neighborhood that promote walking and biking
- Create a vibrant public realm

**MARKET POTENTIAL VALUE**
- Increase residential density
- Increase job density
- Increase diversity of land parcels to create a vibrant land market
- Increase social diversity
- Increase floor area ratio

Source: Transforming Cities with Transit Oriented Development: The 3V Approach (Salat and Olivier 2017)
FINANCING TRANSIT-ORIENTED DEVELOPMENT WITH LAND VALUES

Adapting Land Value Capture in Developing Countries

Hiroaki Suzuki, Jin Murakami, Yu-Hung Hong, and Beth Tamayose

WORLD BANK GROUP
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The Urban Development Series discusses the challenge of urbanization and what it will mean for developing countries in the decades ahead. The Series aims to delve substantively into the core issues framed by the World Bank’s 2009 Urban Strategy, Systems of Cities: Harnessing Urbanization for Growth and Poverty Alleviation. Across the five domains of the Urban Strategy, the Series provides a focal point for publications that seek to foster a better understanding of the core elements of the city system, pro-poor policies, city economies, urban land and housing markets, sustainable urban environment, and other issues germane to the urban development agenda.

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Financing Transit-Oriented Development with Land Values
Adapting Land Value Capture in Developing Countries

Hiroaki Suzuki
Jin Murakami
Yu-Hung Hong
Beth Tamayose

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About the Authors

Principal Authors

Hiroaki Suzuki is the former lead urban specialist of the Urban and Resilience Management Unit of the Urban and Disaster Risk Management Department at the World Bank. Currently, he is a lecturer at the Graduate School of Engineering, University of Tokyo; the National Graduate Institute for Policy Studies (GRIPS); and the Graduate School of Politics, Hosei University. He has more than 30 years of operational experiences within the infrastructure and public sectors and at the World Bank and the Overseas Economic Cooperation Fund, Japan (now the Japan International Cooperation Agency [JICA]). He specializes in the areas of sustainable urban development, transport and land use integration, municipal finance, and innovative urban infrastructure financing. He is the lead author of Eco\textsuperscript{2} Cities: Ecological Cities as Economic Cities (2010); its implementation guide, Eco\textsuperscript{2} Cities Guide: Ecological Cities as Economic Cities (2012); and Transforming Cities with Transit: Transit and Land-Use Integration for Sustainable Urban Development (2013), all published by the World Bank. He earned a master of science degree in management from the Massachusetts Institute of Technology (MIT) Sloan School of Management.

Jin Murakami is an assistant professor in the Department of Architecture and Civil Engineering at City University of Hong Kong. He specializes in the areas of transportation and economic development, development strategy and spatial planning in globalization, and public finance and land policy. His research focuses principally on spatial and financial matters to increase city-regions’ global competitiveness and local livability. He earned his PhD in city and regional planning from the University of California, Berkeley. He is a lead author, Working Group III, of chapter 12, “Human

**Contributing Authors**

**Yu-Hung Hong** is a lecturer of Urban Planning and Finance at the Massachusetts Institute of Technology (MIT) and a visiting fellow at the Lincoln Institute of Land Policy. He is the founder and executive director of the Land Governance Laboratory where he studies the use of land tools to facilitate open and inclusive decision-making processes for land resource allocation in developing countries. He earned his PhD in urban development from the Department of Urban Studies and Planning at MIT.

**Beth Tamayose** is a visiting researcher in the Department of Urban Planning at the University of California, Los Angeles. Her research focuses on land use planning, governance structures, and land and resource access and allocation in the Pacific. She earned her PhD in urban planning from the University of California, Los Angeles.

While this book is the product of a collaborative effort, primary authors for the sections are as follows:

- **Overview**  Hiroaki Suzuki and Jin Murakami
- **Chapter 1**  Hiroaki Suzuki
- **Chapter 2**  Hiroaki Suzuki, Yu-Hung Hong, and Jin Murakami
- **Chapter 3**  Jin Murakami
- **Chapter 4**  Jin Murakami
- **Chapter 5**  Jin Murakami and Beth Tamayose
- **Chapter 6**  Yu-Hung Hong and Hiroaki Suzuki
- **Chapter 7**  Jin Murakami and Hiroaki Suzuki
- **Chapter 8**  Jin Murakami and Hiroaki Suzuki
### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>BRT</td>
<td>bus rapid transit</td>
</tr>
<tr>
<td>CEPAC</td>
<td>Certificates of Additional Construction Potential</td>
</tr>
<tr>
<td>CDA</td>
<td>comprehensive development area</td>
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<tr>
<td>DBLVC</td>
<td>development-based land value capture</td>
</tr>
<tr>
<td>DDA</td>
<td>Delhi Development Authority</td>
</tr>
<tr>
<td>DfT</td>
<td>Department for Transport (UK)</td>
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<tr>
<td>DFI</td>
<td>development financial institution</td>
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<tr>
<td>DIF</td>
<td>District Improvement Fund</td>
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<tr>
<td>DMRC</td>
<td>Delhi Metro Rail Corporation</td>
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<tr>
<td>EWS</td>
<td>economically weaker sections</td>
</tr>
<tr>
<td>FAR</td>
<td>floor area ratio</td>
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<tr>
<td>GHMC</td>
<td>Greater Hyderabad Municipal Corporation</td>
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<tr>
<td>GLUP</td>
<td>General Land Use Plan (Arlington)</td>
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<tr>
<td>GoAP</td>
<td>Government of Andhra Pradesh</td>
</tr>
<tr>
<td>HKSAR</td>
<td>Hong Kong Special Administrative Region</td>
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<tr>
<td>HMDA</td>
<td>Hyderabad Metropolitan Development Area</td>
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<tr>
<td>HS1</td>
<td>High Speed 1</td>
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<tr>
<td>HSR</td>
<td>high-speed rail</td>
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<tr>
<td>JD</td>
<td>joint development</td>
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<tr>
<td>JnNURM</td>
<td>Jawaharlal Nehru National Urban Renewal Mission</td>
</tr>
<tr>
<td>JNR</td>
<td>Japanese National Railways</td>
</tr>
<tr>
<td>KCRC</td>
<td>Kowloon-Canton Railway Corporation</td>
</tr>
<tr>
<td>LCR</td>
<td>London and Continental Railways</td>
</tr>
<tr>
<td>LVC</td>
<td>land value capture</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
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<tr>
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<tr>
<td>MPD-2021</td>
<td>Master Plan for Delhi-2021</td>
</tr>
<tr>
<td>MRTS</td>
<td>Mass Rapid Transport System (Delhi)</td>
</tr>
<tr>
<td>MTA</td>
<td>Metropolitan Transportation Authority (NYC)</td>
</tr>
<tr>
<td>MTR</td>
<td>Mass Transit Railway (Hong Kong SAR, China)</td>
</tr>
<tr>
<td>NCTD</td>
<td>National Capital Territory of Delhi</td>
</tr>
<tr>
<td>NMG</td>
<td>Nanchang municipal government</td>
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<tr>
<td>NMT</td>
<td>nonmotorized transport</td>
</tr>
<tr>
<td>NRTG</td>
<td>Nanchang Railway Transit Group Co., Ltd.</td>
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<tr>
<td>OODC</td>
<td>additional building charge (Outorga Onerosa do Direito de Construir)</td>
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<tr>
<td>O&amp;M</td>
<td>operation and maintenance</td>
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<tr>
<td>ORR</td>
<td>Outer Ring Road</td>
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<tr>
<td>PFI</td>
<td>private finance initiative</td>
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<tr>
<td>PDE</td>
<td>Plano Diretor Estratégico (Strategic Development Plan)</td>
</tr>
<tr>
<td>PITU 2025</td>
<td>Integrated Urban Transport Plan 2025 (São Paulo)</td>
</tr>
<tr>
<td>PPP</td>
<td>public-private partnership</td>
</tr>
<tr>
<td>R+P</td>
<td>Rail Plus Property (program implemented by MTR Corporation, Limited, Hong Kong SAR, China)</td>
</tr>
<tr>
<td>SAR</td>
<td>Special Administrative Region</td>
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<tr>
<td>TAD</td>
<td>transit-adjacent development</td>
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<tr>
<td>TDR</td>
<td>transfer of development rights or transferable development rights</td>
</tr>
<tr>
<td>TOD</td>
<td>transit-oriented development</td>
</tr>
<tr>
<td>UMTA</td>
<td>Urban Mass Transportation Act</td>
</tr>
<tr>
<td>UO</td>
<td>Urban Operation</td>
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<tr>
<td>UTIPEC</td>
<td>Unified Traffic and Transportation Infrastructure Planning and Engineering Centre</td>
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<tr>
<td>VGF</td>
<td>viability gap fund</td>
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<tr>
<td>WMATA</td>
<td>Washington Metropolitan Area Transportation Authority</td>
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*Note:* Unless otherwise noted, dollar amounts are in U.S. dollars.
**Glossary**

**Air right sale.** One of the development-based LVC instruments. Governments sell development rights extended beyond the limits specified in land use regulations (e.g., FAR) or created by regulatory changes to raise funds to finance public infrastructure and services.

**Bus rapid transit (BRT).** High-quality bus-based services that mimic many of the features of high-capacity metrorail systems but at a fraction of the cost. Buses most closely resemble metrorail services when they operate on specially designated lanes or have physically separated lanes for their exclusive use. Grade separation of busways at critical intersections and junctures also expedites flows. BRT systems often include bus stations instead of stops to provide weather protection and allow passengers to pay before boarding.

**Central business district (CBD).** Areas where cities’ major businesses (financial institutions, stores, major convention and sport facilities, hotels, etc.) are concentrated. CBDs produce agglomeration economies.

**Eminent domain.** Regulatory power granted to governments or public agencies, which allows them to take private property for public projects or interests, subject to appropriate compensation.

**Floor area ratio (FAR).** Ratio of a building’s total floor area to the size of the land on which it is built. The higher the FAR, the higher the density. Also referred to as floor space ratio (FSR) or floor space index (FSI).

**Greenfield development.** New development that takes place on lands that were not previously developed as urban land including agricultural, rural, and unused land.
Land readjustment scheme. Landowners pool their land together for reconfiguration and contribute a portion of their land for sale to raise funds to partially defray public infrastructure development costs. This can be used as a development-based LVC instrument to finance transit and TOD-related investments.

Land value capture (LVC). LVC is defined as a public financing method by which governments (a) trigger an increase in land values via regulatory decisions (e.g., change in land use or FAR) and/or infrastructure investments (e.g., transit); (b) institute a process to share this land value increment by capturing part or all of the change; and (c) use LVC proceeds to finance infrastructure investments (e.g., investments in transit and TOD), any other improvements required to offset impacts related to the changes (e.g., densification), and/or implement public policies to promote equity (e.g., provision of affordable housing to alleviate shortages and offset potential gentrification). There are two main categories of LVC: development-based LVC and tax- or fee-based LVC. Development-based LVC can be facilitated through direct transaction of properties whose values have been increased by public regulatory decisions or infrastructure investment. Tax- or fee-based LVC is facilitated through indirect methods, such as extracting surplus from property owners, through various tax or fee instruments (e.g., property taxes, betterment charges, special assessments, etc.).

Market freehold system. Land holding system under which landowners have absolute ownership of land. Its conditions are full right of transfer, right to bequeath, right to mortgage, full use rights (unless restricted by law), and unlimited duration.

Mixed use. Pattern of development characterized by a mixture of diversified land uses, typically including housing, retail activities, and private businesses, either within the same building space (e.g., vertical mixing) or in close proximity (e.g., horizontal mixing).

Nonmotorized transport (NMT). Any type of transport mode that is not motorized, such as walking or bicycling. NMT has gained popularity as not only a clean, carbon-free form of mobility with a very small footprint but also as a means to improve public health through increased physical activity.

Public-private partnership (PPP). Formal partnership between a public sector entity and a private corporation often used to construct and operate infrastructure facilities or develop certain urban areas.
Redevelopment/regeneration. Type of development that seeks to reinvest in already developed areas, typically targeting parcels that are underutilized (e.g., vacant or abandoned properties); often considered part of an economic development scheme.

Sprawl. Pattern of development characterized by uniform low density, lack of a distinctive core, poor accessibility, dependence on automobiles, and uncontrolled and noncontiguous land expansion.

State leasehold system. Land holding system under which lands are owned by the states and the lands are leased by the states to individuals or firms for a fixed duration, with lease fees and other conditions. The rights enjoyed by lessees can vary with specific lease conditions, but terms frequently allow for the right to assign the lease to another or allocate the residual value of the lease. Development and use rights are likely to be restricted by the States.

Transfer of development rights (TDR). Ability to effectively buy and sell “air rights” (i.e., rights to fully develop the maximum allotted vertical envelope—or “air space”—of properties) within the limit of their FAR allotment or the unused development rights that remain when a particular building does not use up its FAR allotment; typically applies only to certain parcels, and the rights often can only be transferred to specific “receiving” parcels.

Transit-adjacent development (TAD). Development that is similar to TOD in that it is located within the vicinity of a transit node but is not actually connected with transit in the absence of pedestrian-friendly development organized around a transit station.

Transit-oriented development (TOD). Compact, mixed-use, pedestrian-friendly development organized around a transit station. TOD embraces the idea that locating amenities, employment, retail shops, and housing around transit hubs promotes transit usage and nonmotorized travel.

Urban redevelopment scheme. Development-based LVC instrument mainly used in Japan. Landowners together with a developer establish one cooperative entity to consolidate piecemeal land parcels into a single site that they then develop (e.g., high-rise building and/or mixed-use building) with new access roads and public open spaces. The local government modifies zoning codes and increases maximum FARs in the targeted redevelopment district (typically around rail transit stations).
Message to City Leaders

Would you like to reduce traffic congestion, promote business, improve public services, and boost revenues? How about making your city more livable, economically competitive, and environmentally and socially sustainable?

One way that cities can achieve these goals is by creating and capturing the benefits of higher land values around urban transit stations and corridors. Needless to say, land has its own intrinsic value. Private investors pay to obtain property rights and develop the land, further pushing up its value. These developers rightly deserve to profit from their investments, but shouldn’t your city, too? Taxes and fees certainly have a role, but in this book, other approaches are explored which will enable cities to reap the benefits of increases in land value attributable to public policies and actions—such as changes in land use regulations and investments in infrastructure, specifically transit-oriented development.

How can your city do this? Cities typically use land sale or lease, joint projects, and air rights deals. For example, a joint project can ensure that the development of transit stations and adjacent private properties is well coordinated, with the developers contributing financially or physically to the construction of the stations because property values will rise, thanks to the new transit facility. Under an air rights deal, governments can sell development rights that allow for higher densities or taller structures beyond the limits specified in land use regulations to raise revenue for public infrastructure and services.

Such deals have many advantages for cities. They help clearly connect increased value from regulatory changes and related investments to funding for transit infrastructure. In addition to obtaining direct revenues resulting from creating and sharing higher land values, you will also get more sustainable revenues in the long run—not just from higher ridership but from new retail shops, parking garages, leisure facilities, and residential buildings around the station.

These deals can be explored not only as financing instruments but also as ways to pursue planning and public policy that is good for both the local
economy and the environment and that encourages more inclusive urban growth. By using some of the proceeds to invest in parks, sidewalks, street lights, and bike lanes, you can work with transit agencies, developers, and communities to jointly develop efficient, attractive, and safe public places, further increasing property values. By offering bonus floor area ratios and other regulatory incentives, you can require developers to provide affordable housing and daycare centers in their new facilities.

One kind of method for capturing land value does not preclude others. They can be applied separately or jointly in ways that best suit the conditions in your city and country. So in choosing how to proceed, you should consider the project’s objectives, its regulatory and administrative feasibility, and its political acceptability.

The perception of land transfers from the public to private sector may be negative in countries where there is a lack of transparency. For this reason, governments or transit companies often find it difficult to secure public support, especially from those living in the targeted property development areas. To build support, your city government can introduce a transparent monitoring and recording system for transactions. All stakeholders need to have access to information on how the private partner has been selected, what public revenues are projected, and how the revenues will be used. Perhaps most important is to require that transactions be at market prices based on independent assessments using established and neutral land valuation principles and practices. It is also important to involve civil society organizations in front-end planning and post-project development activities.

We invite you to consider this book’s examples of how some cities have created and captured higher land values through a strategic mechanism coupled with supportive regulatory changes for sustainable urban finance and development. Hong Kong SAR, China; Tokyo; New York; Washington, DC; and London have generated funds for their transit systems and promoted sustainable urban development. Nanchang, Delhi, and Hyderabad are adapting such an approach for their metro construction.

The majority of cities, especially in developing countries, have not yet fully explored the possibilities. These cities will need to develop their legal and institutional framework and build technical expertise, capacity, and experience under a consistent vision, policy, and strategy. We hope this book will help you find a strategic approach for urban finance and planning that works in your local context. By creating and capturing higher land values around urban transit stations and corridors, cities can recoup some of the costs of building, operating, and maintaining mass transit systems, as well as support transit-oriented development in ways that make them more appealing places to live, work, and do business.
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Overview

Cities in developing countries are experiencing unprecedented growth. But this is often accompanied by the negative impacts of car-dependent urbanization such as congestion, air pollution, greenhouse gas emissions, inefficient use of energy and time, and social inequality of accessibility. The World Bank’s Transforming Cities with Transit: Transit and Land-Use Integration for Sustainable Urban Development (Suzuki, Cervero, and Iuchi 2013) concluded that compact, mixed-use, pedestrian-friendly development organized around a transit station is one of the most effective strategic initiatives to address the negative effects of motorization.

Despite increasing recognition of transit-oriented development as an effective strategic approach for sustainable urban development, most cities, particularly those in developing countries, do not have the practical know-how and expertise to make transit-oriented development happen. Because these cities are almost always under a severe fiscal constraint, they face great challenges in financing capital-intensive mass transit systems to reverse car-dependent urbanization. Development-based land value capture (LVC) in Hong Kong SAR, China; Tokyo; New York; Washington, DC; and London allows these cities not only to generate funds for transit investment and operation and maintenance but also to promote sustainable urban development. If adapted well to local contexts, such schemes have great potential to become an effective finance and planning apparatus for cities in developing countries.

Many rapidly growing cities in developing countries, particularly those in emerging middle-income countries, are endowed with macro conditions for development-based LVC schemes. Strong economic growth, rising real incomes, increasing motorization, and congestion all cause land values to appreciate near transit stations or corridors. And some forward-looking cities in middle-income countries such as Nanchang, Delhi, and Hyderabad are adapting development-based LVC for their metro systems. But the majority of cities in developing countries have not yet fully explored these
favorable conditions to adapt locally-specific development-based LVC schemes. Why? Because they lack a consistent vision, strategy, and policy. They also lack legal and institutional frameworks. And they lack technical expertise, capacity, and experience. This book can help them fill these gaps and adapt their own development-based LVC scheme as a strategic apparatus for urban finance and planning.

**Car-Dependent Urban Development in the Developing World**

The 21st is the century of cities. More than half the world’s people, or 54 percent of the world’s population (UN Department of Economic and Social Affairs 2014), reside in urban areas, and 7 of every 10 people will live in cities by 2050, with about 90 percent of the growth in developing countries (UN-Habitat 2013). Cities globally generate about 75 percent of gross domestic product. But urbanization also bears social, economic, and environmental costs. Cities consume about 67 percent of energy and produce about 70 percent of greenhouse gas emissions. And the problems of car-dependent urban development—congestion, air pollution, greenhouse gas emissions, lengthy commutes, and social inequality in accessibility—have been increasing in rapidly growing cities in developing countries. Enrique Peñalosa, former mayor of Bogotá, said (in 2002), “Transport differs from other problems developing societies face, because it gets worse rather than better with economic development” (Peñalosa 2002). As wealth increases, people shift from walking to bicycling, and then from bicycling to riding motorbikes and to driving cars. By 2050, China is projected to have 900 million cars, or more than the number in the world today (Fulton and Cazzola 2008).

Recognizing the problems of car-dependent urbanization, many cities in developing countries have started to invest in metrorail, light rail, bus rapid transit, and commuter and heavy rail transit. But these systems are extremely intensive in capital. Beyond the upfront construction costs, operation and maintenance also require substantial cross-subsidies from other revenue sources because fare revenues in most cities are insufficient (Murakami 2012). Such operational deficits are due in large part to the weak integration of transit infrastructure with urban development. And suitable development schemes are often unavailable for transit and planning agencies in developing countries (Suzuki, Cervero, and Iuchi 2013).

These constraints have stimulated interest in development-based LVC for transit financing and sustainable urban development. Indeed, Hong Kong SAR, China; Tokyo; Osaka; and Singapore have been using it to finance transit costs and promote sustainable urban development.

**Development-Based Land Value Capture as a Strategic Apparatus for Transit Financing and Urban Planning**

The notion of land value capture is to “mobilize for the benefit of the community at large some or all of the land value increments (unearned income)
generated by actions other than the landowner’s such as public investments in infrastructure or administrative changes in land use norms and regulations” (Smolka 2013) (figure O.1).

Unlike taxes and fees, development-based instruments capture land value increments by selling or leasing land, development rights, and air rights. Under such schemes, governments, transit agencies, developers, and landowners jointly increase land values by exploring development opportunities of transit station areas and sharing increments in land values.

Development-based LVC has the following advantages over taxes and fees in financing transit and transit-oriented development related investments (table O.1):

- It has greater potential to finance capital-intensive transit and transit-oriented development related investments without significant fiscal distortion or public opposition to additional taxes or fees.
- It can generate not only direct revenues from incremental land value increases attributed to transit investments but also more sustainable long-term revenues from higher transit ridership and retail shops, leisure facilities, parking, and residential buildings in the precinct of station areas.

**Figure O.1 Land values and their attribution**

The government, on behalf of the general public, should keep this portion of the land value.

Public service providers should capture this portion of the increment to cover the costs of public infrastructure and local service provision.

Private land owners should profit from this portion of the increment.

Land buyers (or lessees) pay sellers (lessors) to obtain the property rights of land.

*Source: Adapted from Hong and Brubaker 2010.*
• It involves transacting land rights, development rights, or air rights whose values have increased due to public investment or regulatory changes. It establishes a clear link between creating value and capturing value. In addition, the increment in land value is calculated using a method agreed by stakeholder consensus. By contrast, taxpayers often contest the coverage and amount of taxes or fees because the definition of benefits created by public intervention is often vague, the accuracy of the estimated incremental value is often challenged, and the calculation methods are not well defined.

• It has a much better chance of working well administratively in places with an inadequate property tax system (outdated cadasters, weak capacity for assessing value), as in most cities in developing countries.

Governments can explore development-based LVC not only as a financing instrument but also as an urban planning and public policy instrument to promote economic competitiveness, environmental sustainability, and social equity:

### Table O.1 Selected land value capture instruments

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Property and land tax</strong></td>
<td>Tax levied on estimated value of land or land and buildings combined, with revenues usually going into budgets for general purposes.</td>
</tr>
<tr>
<td><strong>Betterment charges and special assessments</strong></td>
<td>Surtaxes imposed by governments on estimated benefits created by public investments, requiring property owners who benefit directly from public investments to pay for their costs.</td>
</tr>
<tr>
<td><strong>Tax increment financing</strong></td>
<td>A surtax on properties within an area that will be redeveloped by public investment financed by municipal bonds against the expected increase in property taxes. Mainly used in the United States.</td>
</tr>
<tr>
<td><strong>Land sale or lease</strong></td>
<td>Governments sell developers land or its development rights, whose values have increased thanks to a public investment or regulatory change, in return for an up-front payment, leasehold charge, or annual land rent payments through the term of the lease.</td>
</tr>
<tr>
<td><strong>Joint development</strong></td>
<td>A well-coordinated development of transit station facilities and adjacent private properties between transit agencies and developers, where the latter usually contribute physically or financially to the construction of the station facilities, as their property value will increase thanks to the transit investment. Used in Japan, the United States, and other countries.</td>
</tr>
<tr>
<td><strong>Air rights sale</strong></td>
<td>Governments sell development rights extended beyond the limits specified in land use regulations (such as floor area ratios [FARs]) or created by regulatory changes to raise funds to finance public infrastructure and services.</td>
</tr>
<tr>
<td><strong>Land readjustment</strong></td>
<td>Landowners pool their land and contribute a portion of their land for sale to raise funds and partially defray public infrastructure development costs.</td>
</tr>
<tr>
<td><strong>Urban redevelopment schemes</strong></td>
<td>Landowners and a developer establish a cooperative entity to consolidate piecemeal land parcels into a single site that they then develop (such as a high-rise mixed-use building) with new access roads and public open spaces. The local government modifies zoning codes and increases maximum FARs in the targeted redevelopment areas (typically around rail transit stations) and finances the infrastructure. Mainly used in Japan.</td>
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• By changing land use regulations, such as allocating higher floor area ratios (FARs) and converting land from single to mixed use, governments can increase densities in station areas for diverse uses while increasing revenues.
• By using proceeds for investments in station areas (such as parks, street lights, bike lanes, and pedestrian sidewalks), governments, transit agencies, developers, and communities can jointly develop efficient, attractive, and safe public places, further increasing property values.
• By providing bonus FARs or other regulatory incentives, governments can require developers to include social facilities and affordable housing in exchange for the additional rights.

This is not to deny the usefulness of tax- or fee-based schemes, which have their own advantages. For instance, the revenues from property taxes can be sustainable because their collection does not deplete finite land resources. Nor does adopting one category of LVC preclude adopting another. Taking into account the different objectives, the regulatory and administrative feasibility, and the political acceptability of public infrastructure finance, these different instruments can be applied separately or jointly in ways that suit the conditions of countries and cities.

Global Good Practices for Development-Based LVC

Two global cities in Asia—Hong Kong SAR, China, and Tokyo—provide cases of successful large-scale development-based LVC as a strategic apparatus for sustainable urban finance and development. They have been applying development-based LVC not only to recoup the costs of mass transit construction, operation, and maintenance but also to support transit-oriented development for sustainable urban development.

Hong Kong SAR, China’s, R+P Program

Hong Kong SAR, China, is one of few global cities whose rail transit sustains the world’s densest urban form productively. The 218-kilometer Mass Transit Railway (MTR) network consists of 10 railway lines with 84 stations serving Hong Kong Island, Kowloon, and the New Territories, with more than 4 million passenger trips a day. Due to the high ridership, MTR generated a net operating profit of HK$6.694 billion (US$869 million) from its transit operation and achieved farebox recovery of 185.5 percent for 2012. This financial success is thanks to the Rail Plus Property (R+P) program implemented by the MTR Corporation (map O.1).

Under the R+P program, the Hong Kong SAR, China, government gives exclusive property development rights of government-owned land at a “before-rail” market price. MTR then captures the land value increment created by R+P, such as accessibility and agglomeration benefits thanks to transit and transit-oriented development related investments, by partnering with private developers in developing the land and selling the completed
development at an “after-rail” market price. It recoups the capital, operating, and maintenance costs of railway projects through sharing profits (figure O.2). R+P also allows MTR to integrate different phases of rail and property development projects, ensuring smooth project implementation and reducing transaction costs.

From 2000 to 2012, property development produced 38 percent of MTR’s corporate income, related businesses (such as commercial and property lease and management business) 28 percent, and transit operations 34 percent. From 1980 to 2005, the government received $18 billion equivalent in net financial returns, with earned income from land premiums, market capitalization, shareholder cash dividends, and initial public offer proceeds of $22.2 billion equivalent, minus the equity capital injected of $4.2 billion equivalent. Although MTR is entitled to capture land value increments, its financial benefits are distributed to the government through dividends and appreciation of the value of its shareholding. MTR also contributes to sustainable urban development and economic development by providing efficient transit services and high quality property development.
The following key principles ensure the program’s effectiveness:

- Master plans and policy documents consistently state the importance of an MTR network as a “backbone” of urban and regional development, particularly during a rapid growth period.
- A public leasehold system controls urban land supply, attracts private resources, and ensures public interests around new railway corridors.
- The Comprehensive Development Area zoning sets special FARs around key stations to attract private investment to strategic locations, while providing flexibility for private developers to negotiate and design.
- Property development rights are exclusively granted at a pre-rail market price for a business-oriented rail corporation to cover the capital and running costs of a rail project and to master multiple functions and phases of rail and property development at lower transaction costs.
- The granting of development rights starts with small parcels above stations or depots primarily to generate project revenue and later evolves into large-scale, high-quality new towns, iconic business centers, and local community hubs.
- Private developers cover land premiums and bear project risks for higher financial returns, whereas the government and rail corporation (to some degree) are protected from market and development risks.
- The rules for sharing costs and profits among public agencies, the railway corporation, and private developers are clear and sound, easing project uncertainties and public opposition.
• Development parameters for rail stations vary by locations based on market demand and socioeconomic conditions.
• After project completion, the railway corporation stays on as an asset manager not only to capture the upfront profits of property development but also to maximize management-related recurring revenues from the long-term business portfolio.

Tokyo’s Diverse and Inclusive LVC Schemes
A 3,500-kilometer extended railway network with about 2,000 stations operated by 48 transit agencies serves Tokyo, the world’s largest metropolis with 37 million inhabitants (map O.2). Tokyo provides one of the best

Map O.2 The Tokyo metropolitan area
a. Polycentric regional structure
b. Urban regeneration special districts
c. Railway network built, operated, and owned by multiple public-private agencies

Source: Based on data from National Land Information, Ministry of Infrastructure, Land, and Transport (MILT), Japan.
experiences in applying development-based LVC to finance railway investments with the revenues from real estate development. Unlike Hong Kong SAR, China’s, state leasehold system, Tokyo’s schemes operate under a market freehold system.

Land readjustment is mainly used on urban fringes, and urban redevelopment schemes in built-up areas especially, where property rights are fragmented (boxes O.1 and O.2). Both instruments, however, require either

**Box O.1 Integrated land readjustment for Tsukuba Express**

Under the Housing-Railway Integration Law, municipal governments and housing agencies can designate special land readjustment areas along future railway lines. In this scheme, several landowners within the designed areas give up and reserve percentages of their land for public uses, including the transit facilities or land sales to generate funds for public investments (figure BO.1.1). The economic rationale is that although the original landowners receive smaller land parcels, these parcels would have higher land values thanks to a new station and other local infrastructure and service provision. Railway companies can smoothly acquire the rights of way for their transit investment and promote transit-supportive housing developments through the land readjustment practices.

**Figure BO.1.1 Integrated land readjustment**

Source: Adapted from the Chiba Prefectural Government 2009.
Box O.2 Inclusive urban redevelopment scheme, Japan

Under the Urban Redevelopment Law, landholders, tenants, and developers can create development opportunities in built-up areas, typically where a transit station exists or has newly opened. To capture the potential accessibility benefits conferred by the transit station, the local government first converts zoning codes from single use to mixed use with higher floor area ratios (figure BO.2.1).

Figure BO.2.1 Inclusive urban redevelopment scheme, Japan (hypothetical)

Before the urban redevelopment project, the site consisted of several small parcels owned by individual landowners and occupied with different tenants. Most houses are one- or two-story structures because each parcel is too small to replace the old building with a taller building, and the landowners do not have the capital or expertise to do so. This urban redevelopment project consists of construction of a taller, higher-quality building on land prepared by assembling small parcels; construction of an underground metro station; and provision of public infrastructure (such as wider roads, a station plaza, and amenities). The national government finances a third of site survey, land assembly, and open space foundation costs, using the national general budget, and half the public infrastructure costs using the roadway special fund. Through this process, the original landholders and building (continued next page)
The world’s largest metropolis has adapted LVC to match the variety of stakeholders, locations, time periods, and scales over the world’s most expansive railway network. Tokyo’s rich transit-oriented experiences offer the following lessons:

- The national government’s master plan leads to polycentric regional development and railway extension strategies, even though multiple public, private, and semi-private entities use different development approaches and LVC techniques in the same metropolitan area. All stakeholders need to share a clear vision and take collective actions.

- Both the land readjustment and urban redevelopment schemes require a consensus building that is often very thorough and time-consuming. And smooth implementation relies on traditional social ties and adequate economic incentives. The power of eminent domain can help practitioners speed land assembly, but careless application could generate long-lasting social tensions and feelings of mistrust.

- Entrepreneurial railway agencies should also acquire expertise not only for conventional system engineering but also for real estate investment.

### Table BO.2.1 Stakeholder contributions and benefits

<table>
<thead>
<tr>
<th>Stakeholders</th>
<th>Contribution</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landholders (A, B, C, D, E, F &amp; G)</td>
<td>Land parcel for the new building</td>
<td>Joint ownership of land for the new building (sections A, B, C, D, E, F &amp; G) with higher access and better local infrastructure and service provision</td>
</tr>
<tr>
<td>Building owners (a, b, c, d &amp; f)</td>
<td>Old buildings and housing units</td>
<td>Ownership of the new building (sections a, b, c, d &amp; f) with higher access and better local infrastructure and service provision</td>
</tr>
<tr>
<td>Developer</td>
<td>Capital and property development expertise</td>
<td>Profit from section X and from surplus FAR</td>
</tr>
<tr>
<td>Transit agency</td>
<td>Construction of transit station</td>
<td>Transit-supportive environment/increased ridership</td>
</tr>
<tr>
<td>National government</td>
<td>Subsides for land assemblage and road construction</td>
<td>Save road and other public infrastructure construction costs</td>
</tr>
<tr>
<td>Local government</td>
<td>Change in zoning code (from single use to mixed use with higher FAR)</td>
<td>Yields higher property tax revenue; promotes local economic development; builds townships resilient to natural disasters</td>
</tr>
</tbody>
</table>

*Note: FAR = floor area ratio.*
town planning, and marketing to set appropriate development parameters, analyze market profiles, offer multiple services, and maximize value increments in their station properties and wider catchment areas. Essentially, railway agencies need to be entitled to keep the long-term ownership and stewardship of properties to generate recurring revenues from both development and service activities around stations.

- The rights of way for a new railway line can be assembled cost-efficiently by railway agencies and local governments through land readjustment projects, especially in areas where local residents are waiting for new railway access. This approach can promote property development along the new line to achieve targeted ridership and fare revenues.

- Major landholders or developers in a designated district can foster land readjustment projects. With their real estate knowledge and resources, they are more likely to invest in local infrastructure, take strong initiatives in planning, and maximize the value of their land around a new station.

- To create high-quality built environments around a station, substantial density bonuses should be provided. Private transit agencies and developers are encouraged to supply social infrastructure and services, maximize synergies, and mitigate redistributive impacts through inclusive urban redevelopment. They can provide human-scale built environments within the superblocks already constructed in many developing countries.

Tokyo’s multiple techniques provide lessons for the rapidly growing cities of developing countries.

**Critical Factors for Success in Developing Countries**

Case studies of cities that have creatively pursued development-based LVC to finance transit and transit-oriented development in both developed and developing countries highlight the unique contexts and challenges of creating and sharing land values for transit financing and transit-oriented development. The insights from these experiences point to policy recommendations and implementation measures that deserve careful consideration at different levels of strategic decisions. They also highlight policy decisions, planning exercises, and project development in applying development-based LVC in developing countries.

**Key Findings**

*Inclusive Value Creation*

The rationale behind development-based LVC is creating and sharing incremental value among the governments, transit agencies, developers, businesses, and residents in and around stations. This obviously differs from tax- or fee-based capturing of “windfalls” from private property owners,
as practiced in North America and other parts of the world. The Japanese expression of development-based LVC (“開発利益還元”) literally means “returning profit generated by development,” rather than having the government or transit company unilaterally capture the land value increments from landowners or developers. Development-based LVC is designed and implemented around the incentives of various stakeholders. This shared interest facilitates various complex property development processes such as acquiring land and authorizing land use change and zoning codes. Unlike most tax- or fee-based LVC instruments, evaluating increment value in development-based LVC is not a unilateral decision by municipalities. The land price is agreed on by all parties up-front based on market trends, and the distribution of profit is decided through negotiations, based on the contribution of each stakeholder.

**Public Land Ownership Is Important but not Absolutely Necessary**

Development-based LVC is a value creation exercise rather than a simple sale of public land or lease of land use rights. Even under a market freehold system, municipalities and transit agencies that do not own land can acquire land through incentive-based techniques such as “land readjustment” or “urban redevelopment,” as applied in Tokyo. These can generate land values exceeding the land purchase costs by exploring undeveloped economic opportunities through densification, transit, and other transit-supportive investments. New York City and São Paulo are also exploring vertical development opportunities by leveraging air rights of the lands owned by private landowners in densely built-up districts (box O.3).

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**Box O.3  Air rights sales in São Paulo**

Brazil is a pioneer in air rights sales, but these sales have rarely been adapted to finance transit or transit-oriented development related investments in São Paulo.

In Brazil, a private landowner cannot freely develop air rights above a certain floor area ratio (usually between 1.0 and 2.0 in São Paulo) without paying for the costs of the impact of the air rights use. The logic behind selling air rights is that owners should contribute to infrastructure construction costs in proportion to the volume of their air rights use, as higher densities require additional infrastructure investments. Certificates of Additional Construction Potential (CEPACs) are sold by auction as a tradable financial security, and they are applicable only to designated urban districts, with the revenues to finance predetermined urban infrastructure. Through the issue of CEPACs, municipalities can raise infrastructure investment funds by selling the bearer additional building rights—such as a larger floor area ratio and possible land use changes—that would induce private investments to adjust to the transformations desired in urban development policy.

São Paulo’s highly indebted financial position forced city authorities to generate funds for infrastructure without increasing debt. Unlike many cities in developing countries, São Paulo cannot raise revenue by selling land because it possesses little developable land. So, air rights sales are one of a few possible measures for São Paulo to raise funds for infrastructure investments. By auctioning CEPACs, the city can allocate limited air rights according to market needs at a price to be fixed by market demand.

(continued next page)
Box O.3 Air rights sales in São Paulo  (continued)

Except for a few minor investments, CEPAC revenues have not been used for metro construction. Nor have allocations of CEPACs been linked to railway station areas. So, CEPACs have not always captured the increments of land value attributable to metro construction. Further, the state government and the city government are not controlled by the same political party, making coordination between transit agencies and the urban planning department difficult. Even in the same transport sector, railway transit companies owned by the São Paulo State and bus companies owned by the municipality seem to compete rather than collaborate. Due to lack of coordination between transit agencies and city planning bureaus as well as agencies’ railway-centered engineering approaches, transit agencies often miss out on great opportunities to explore the use of air rights above stations to generate revenues. Given the tight budget situation and legal restrictions, metro company engineers tend to design metro stations according to minimum structural specifications requiring the least investment costs. But these developments cannot support the type of multipurpose use terminal building that could generate sizable lease revenues and increase transit ridership.

Although São Paulo currently faces these planning and institutional challenges, there is great potential to adapt development-based LVC for transit investment and to shape urban form and develop articulated densities suitable for future transit-oriented development. This approach has already been adapted in the “Linha Verde” (Green Line) Urban Operation in Curitiba, where a major national highway was converted into an urban avenue with the extension of a bus rapid transit green line and higher density land uses. CEPAC revenues partially financed the investment costs of this transit-oriented development project (Smolka 2013). In São Paulo, the Metro has already started to study the possibility of using air rights sales to finance new metro construction in the Vila Sonia Urban Consortia (Fróes and Rebelo 2006).

In addition, São Paulo’s city planners are now considering to reduce the overcrowded commuting movement between suburbs and city centers by developing subdevelopment centers to balance business and residential densities across the city area (Região da Jacu-Pêssego as a new commercial center and Região da Cupecê for both commercial and residential use), based on the transit-oriented development concept where developable lands are still available. As the demand for good quality housing at the mid-market segment is very high because of rapid household income increase in Brazil, land prices close to transit stations could increase due to good accessibility and connectivity. If the municipal government and transit agencies collaborate and coordinate with investors and developers, as their counterparts in Hong Kong SAR, China, and Tokyo have been doing, they would be able to raise revenues to recoup a portion of the transit and other transit-oriented development related investment costs.

For cities with a state leasehold system, strategic public land use is imperative for successful development-based LVC implementation. Public land is a finite resource in cities—especially growing ones—and would be hastily exhausted if municipalities sold it for short-term cash flow. Municipalities as landholders must therefore strategically manage limited public land, taking into account long-term development benefits. The Hong Kong SAR, China, MTR captures the land value increment created by R+P not by selling the development rights, but by partnering with private developers, selling the completed property units, and finally capturing the value through the sharing of profits. In this sense, regardless of the differences between the respective landholding systems, both the Hong Kong SAR, China, MTR and the Japanese railway companies have been undertaking development-based LVC, based on creating and sharing value.
Sound Planning Principles
Revenue maximization is important because developable land is scarce in rapidly growing cities, but development-based LVC should be based on sound planning principles that increase the benefit of society as a whole. If these schemes are co-opted by cities to simply raise money, and not to try to plan cities sustainably, they may “distort the purposes of planning by putting the focus on benefits extracted from developers rather than on the actual needs of new residents and businesses” (Rahenkamp 2013). In this context, policymakers and practitioners should design development-based LVC so that the transaction generates land value increments that benefit society to the greatest extent possible (box O.4). In a different context, the unintended negative impact of São Paulo’s planning regulation on free FAR limit (between 1.0 and 2.0), combined with its air rights sales on its spatial development pattern (urban sprawl and shortage of affordable housing stocks in the city center), should be carefully analyzed. So should the impact of Hong Kong SAR, China’s, land lease policy on the affordability of local housing.

Enabling Factors
Macro Fundamentals
Demographic and economic fundamentals are paramount when applying development-based LVC. Generally, it works well when rapid urban population and strong economic growth create high demand for land and property prices increase. But even under slow economic growth, municipalities and transit agencies can adapt it to maximize accessibility and agglomeration premiums around selected station areas where the economic potential has not yet been fully realized due to inadequate land uses and outdated zoning codes.

The emergence of middle-income households—and high housing demand—can justify large-scale investment in rail extensions to suburbs

Box O.4 Development rights leases in Nanchang, China
Chinese cities have long converted rural agricultural land to urban land equipped with infrastructure and then leased the development rights for a premium. And as in many other Chinese cities, revenues from development rights leases are the major public finance source of infrastructure investments in Nanchang. But Nanchang, one of several forward-looking Chinese cities, is using development-based LVC schemes to promote transit-oriented development by creating articulated densities around major metro station areas. The idea is to maximize development rights lease revenues to recoup new metro investment costs by promoting efficient land use around stations through zoning changes for mixed use with higher floor area ratios—and to promote sustainable urban development through transit-oriented development.

Nanchang’s practice is more sustainable than the typical rural-urban land conversion, which runs the risk of unnecessarily expanding cities outward, leading to urban sprawl. As this scheme has not yet been fully implemented, it is still too early to know whether it will generate the desired financial and urban development outcomes. But if successful, Nanchang’s scheme could provide a good model for other Chinese cities.
and generate up-front value increments along new corridors. The metro corporations in Nanchang and Hyderabad are taking advantage of their growth, as Japanese private railways exercised development-based LVC for the initial infrastructure investments in the 1960s and Hong Kong SAR, China’s, MTR Corporation in the 1980s.

Both Tokyo and Hong Kong SAR, China, could generate steady recurring revenues, even during periods of slow economic growth, since their instruments were well positioned for long-term development benefits rather than short-term financial gain. Tokyo’s development-based LVCs are still being undertaken, thanks to market demand to consolidate land parcels for redevelopment and regenerate property values in selected strategic built-up areas with high economic potential.

Economic restructuring from low-cost manufacturing to knowledge- and service-based industries, as in Nanchang and Hyderabad, also provides greater opportunities to capture accessibility and agglomeration benefits around stations, where firms and workers can explore value-added business opportunities through agglomeration. Indeed, the competitive advantage of international and regional businesses in Tokyo, New York, and London has shifted toward central locations thanks to recent urban regeneration programs, taking advantage of strong infrastructure reinvestments, land use deregulation, and tax incentives.

**Visionary Master Plans**

A master plan needs to provide a long-term vision of development shared among all members of a city. Policymakers must emphasize transit infrastructure as the spine of spatial development strategies in their visionary plans, helping guide planning, funding, construction, and operations in a way that supports transit. This long-term development vision should be consistently reflected in other planning instruments such as diverse sector plans and local master plans.

Master plans from the past decades of global good practice cities clearly identified rail transit systems as the backbone of urban development. Hong Kong SAR, China’s, territorial development strategies in the 1980s and 1990s anticipated growth areas along with a series of MTR extensions. Tokyo’s latest national capital region master plan also stresses the formation of business cores and nine satellite centers that are well served by multiple rail lines. Nanchang’s comprehensive development plan considers the metro railway system redirecting industrial and housing development from the old center to newly planned areas on a metropolitan scale. The location of key corridors and nodes for future development should be specified based on this vision, taking into account the feasibility of transit investment, market demand, and availability of developable land.

To formulate and revise master plans in a pragmatic way, national governments, metropolitan bodies, and city authorities need to invite multi-level stakeholders and cross-sectoral professionals to come together to share key information and address mutual interests. The National Capital
Region Plan of Tokyo has long coordinated potential development areas and authorized specific transit projects among multiple local governments and railway corporations. By contrast, the Master Plan for Delhi as the national capital region has been unable to resolve many conflicting bureaucratic interests and unfavorable land use regulations, which significantly blocks development-based LVC practices for the new metro system.

Master plans should not be too prescriptive. Development parameters depend on diverse site conditions and changing market demands, though transit-oriented development in general has a certain set of design principles. The overly standard and impractical criteria stipulated in the master plans of Delhi (maximum FAR of 1.0 at metro stations) have reduced or completely negated the opportunities for developers to coordinate better layout plans and maximize accessibility to their real estate.

In addition to the metropolitan master plans, there are various sector or local master plans across government departments and agencies. Such sub-plans must be consistent vertically among national, metropolitan, and local governments—and horizontally among departments of urban planning, land administration, transport, economic development, and housing—all under one consistent vision. For example, new transit investments cannot create enough ridership and associated land value if subplans encourage public spending on massive roadway systems and automobile-dependent housing development. In Hong Kong SAR, China, and Tokyo, transit-supportive policies and investment have been endorsed throughout a subset of sector plans or local master plans.

**Flexible Zoning**

Development-based LVC facilitates negotiations among planning authorities, transit companies, developers, landowners, and local stakeholders for mutual interests and benefits. So zoning codes and site design parameters around stations should be flexible enough to meet changing market demands and diverse local needs.

Zoning systems can provide flexible and negotiable codes with minimum standards to target station areas, allowing transit companies and developers to adjust site-design parameters. In Hong Kong SAR, China, Comprehensive Development Areas have been designated around key stations as set out in the MTR Corporation’s Master Layout Plan to coordinate more complex, integrated mixed-use development packages and to flexibly exercise the financially viable R+P program. Tokyo’s urban regeneration districts were designated to attract private real estate investments with generously relaxed development codes around the former rail yard sites (maximum FAR over 10.0, height deregulation, and expedited approvals).

In many developing countries, outdated land use plans or inconsistent regulations enforced by planning and statutory authorities deter transit agencies and real estate companies from exploring development opportunities in and around stations. For example, the Delhi Development Authority has strictly fixed maximum building coverage at 25 percent, with a FAR of
1.0 for any development activities at metro station areas. But under the new draft master plan (MPD-2021), it is proposing to allocate a higher FAR in the metro influence zones outside metro station sites. One official justification for the strict development regulations in Delhi is that increasing the maximum FAR around stations generates additional trips and exacerbates traffic congestion. But newly attracted travelers are more likely to choose transit and nonmotorized travel modes in origins and destinations near stations. Indeed, the most typical issue preventing flexible land use is the conflict of development interests inside and outside station areas.

Relaxing development regulations around stations alone does not ensure transit-supportive land use. To achieve this, municipalities and transit agencies need to coordinate the physical integration of rail station facilities with private property development and surrounding neighborhoods. Such integration can enhance a transit’s accessibility and produce greater revenues from both transit farebox collections and development-based LVC schemes. In Delhi, nevertheless, a residential condominium project undertaken by a private developer along the metro depot is filled predominately with luxury 3–5 bedroom units having about four parking spaces per household. This can be regarded as transit-adjacent development rather than transit-oriented development (box O.5).

**Box O.5 Government-led development-based land value capture for India’s first metro system in Delhi**

The Delhi Metro Rail Corporation (DMRC) is India’s first metro system, extending over 190 kilometers with 144 stations. It has enjoyed very strong political and financial support from the national government, which leased land owned by various ministries and public agencies to DMRC for metro construction over a 99-year period at an intergovernmental transfer rate lower than the market rate. The government provided the land for property development to finance 11 percent of the construction costs of the first two phases. The government also provided the remaining financing, including budgetary support, together with the Delhi government, and secured yen loans from the Japan International Cooperation Agency by providing a sovereign guarantee. DMRC reports only to the Ministry of Urban Development, which coordinates with other relevant ministries and agencies, while DMRC holds all the decision-making power for metro construction and operation.

But Delhi’s complex governance and regulatory framework is a direct result of multiple layers of government stakeholders—the national government, Delhi government with three municipalities, and the Delhi Development Authority (DDA; a state enterprise in charge of land management and policies, under the Ministry of Urban Development)—which has adversely affected the implementation of development-based LVC. While the national cabinet mandated DMRC to carry out property development projects to finance its construction cost, DMRC had difficulty obtaining development approval from different authorities such as DDA and the municipal government for the floor area ratio modification, the land use change for property development, and the construction permits. Effectively, the decision of the national government is being blocked by lower governments and planning and land management agencies that have statutory approval powers over the change of land use or construction permit. While DDA approved the land use for the right of way, it often rejected DMRC’s applications for the land use change for property development.
Multiple Funding Sources

Development-based LVC should not be regarded as a single funding source to fill any funding gaps. In theory, the primary funding source for transit systems must be the fare revenue that can be increased by adopting transit-oriented development principles around stations. But few transit agencies in the world can cover even their operation and maintenance costs with fare revenues alone. The capital intensity of transit investment further increases the financing challenges for municipalities and transit agencies. Given the broader economic, environmental, and social roles of transit systems, including a range of externalities and social benefits, governments should help transit agencies close their financial gaps by mobilizing diverse funding sources.

Development-based LVC accounts for a substantial portion of transit finance in Hong Kong SAR, China, and Tokyo. But it should not be considered as a single financing source to cover expensive transit costs. As transport economists have long argued, the primary funding source for transit systems should be fare revenue, which should ideally increase with effective transit-oriented development. Railway finance models in Hong Kong SAR, China; Tokyo; Nanchang; Delhi; and Hyderabad assume that fare revenues will fully cover operation and maintenance costs and partially cover construction costs, primarily thanks to adequate passenger demand driven from their high-density passenger catchment areas. But even in such an exceptionally high-density area as Hong Kong SAR, China, the MTR Corporation sometimes relies on government cash grants when the R+P scheme cannot fill a funding gap, especially because of the scarcity of developable land parcels along new lines.

Land prices by their nature are volatile in response to changing economic and political climates, which are beyond the control of local governments or transit agencies. So a variety of alternative funding sources should be available to mitigate the risks of volatile land prices, through diversification of funding sources, and to prepare contingent financing sources in case of lower revenues from development-based LVC. Diversified funding arrangements can ensure the provision of transit infrastructure and services for the long term.

Any special funds run the risk of being captured by special interests—sometimes for economically unjustifiable investment, as with economically nonviable highway construction funded by a road fund. But if designed well, special funds could support governments’ planning objectives and address externalities. For example, governments could apply a gasoline tax or automobile charge as strategic funding arrangements to supplement transit and transit-oriented development related investments and discourage automobile use. Tokyo’s Roadway Special Fund—comprising earmarked gasoline charges and vehicle registration fees—financed one-third of transit-related bridge and underpass construction to reduce traffic congestion and upgrade station facilities to improve local feeder access, pedestrian circulation, and street amenities, along with the land readjustment and urban redevelopment schemes.
Among several funding sources, property taxes are particularly important for municipal governments, transit agencies, developers, landholders, and commercial entities around stations. Such taxes not only support the provision of infrastructure and services but also determine the distribution of development benefits in and around station facilities. Indeed, the special exemption of property tax for railway development and railway-associated businesses have been debated in Tokyo and Delhi, since railway corporations take advantage of the exemption without considering the redistributive effects of railway and property development in and around stations.

**Intergovernmental Collaboration**

Development-based LVC requires multiple government entities to work together to deliver innovative transit-related projects and programs, and that is one of the biggest challenges in many cities of developing countries. One recommended approach would be for a single local government body—which includes transit agencies—to coordinate planning, design, land acquisition, construction, operation, and asset management to sustain collaborative relationships and actions.

The culture of transit agencies is traditionally engineering-oriented, with a focus on narrowly defined performance criteria, even though development-based LVC needs expertise and intergovernmental collaboration beyond transit facilities. It is crucial for transport officials to recognize the financial potential and social importance of dealing with land and property around their transit stations. In both Delhi and São Paulo, the national or state transport bureaus have been less involved in adapting development-based LVC due in part to their technical focus, the multiple layers of governments (sometimes controlled by different political parties, as in São Paulo), and the complicated land and development right transfers from one agency to another.

Development-based LVC usually involves a wide range of government agencies to create greater development opportunities, generating conflicts of intergovernmental interests in lands and properties around stations. In many capital cities, such as Delhi and São Paulo, multiple layers of governments have long adopted their own legislative policies and design parameters. Delhi planning authorities and statutory bodies have used their regulatory instruments to block property development projects mandated by their national government around metro stations and to prevent the full exploration of development opportunities the new metro investment could bring.

Trusted political leaders may be able to remove such intergovernmental barriers and regulatory constraints by bringing all stakeholders together. But such a top-down approach might not always work well in democratic cities. In addition to political support, it is important that one government body acts as a coordinator to deal with land-related legislative tasks across agencies. In Hyderabad, a transit agency is a liaison to ensure that a private partner can smoothly obtain land for metro construction and property development by coordinating with several municipalities, traffic and
police departments, and utility agencies for multiple statutory clearances (box O.6).

**Entrepreneurship**

Transit agencies need to become entrepreneurial as they manage development-based LVC’s evolving process from a simple tool of short-term corporate or project finance to a strategic model of long-term urban finance and development—mainstreaming property development and asset management around stations as a part of their businesses. To ensure the sustainability of these property-related businesses, transit companies have to develop a consensus with other stakeholders on the ownership of and responsibilities for land and property management in and around stations.

Development-based LVC was originally an entrepreneurial undertaking in the mid-19th century in the United Kingdom and the United States. Around the turn of the 20th century, a few entrepreneurs in Japanese cities began adapting the classic private railway and land development business model. Since then, more railway corporations have evolved development-based LVC from a simple tool of short-term project finance to a strategic

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**Box O.6 World’s largest public-private metro project in Hyderabad**

Hyderabad, the largest historical city of southern India, home of 7 million citizens and prosperous information technology industries, is implementing the world’s largest public-private partnership (PPP) for a metro project, extending 77 kilometers and with 66 stations. The PPP project is being implemented in the form of design-build-finance-operate-and-transfer under a 35-year concessionary agreement between Hyderabad Metro Rail Ltd. (HMR) and Larsen and Toubro Limited (L&T; one of the largest contractors and developers in India). HMR is a Special Project Vehicle set up by the state government of Andhra Pradesh (GoAP) to coordinate and manage the project. Through HMR, the state government and the municipality provided L&T with the right-of-way for metro construction and land for property development (109 hectares) close to the metro stations.

L&T will finance most of the metro construction costs ($2.7 billion) and expects to recover them over a 35-year concession, extendable for 25 years. Revenue sources include fare revenues (50 percent of the total), property development (45 percent of total revenues from 109 hectares of leased land), and a viability gap fund (VGF), which receives subsidies from the national government to fill the financial gap of the PPP project and others. The criterion for selecting the concessioner was the amount of VGF requested by the bidders. L&T, which requested the smallest VGF ($320 million), won the award. The Hyderabad Metro Project is a unique example of a PPP using development-based LVC as its financing scheme.

Hyderabad’s institutional and regulatory framework is less complicated than Delhi’s and more straightforward. On the government’s side, stakeholders such as the heads of various departments of GoAP—including the Chief Secretary, the Commissioner representing Greater Hyderabad Municipal Corporation, and the Managing Director of HMR—sit on the board of HMR. HMR is assuming the role of a one-stop-shop representing the governments vis-à-vis L&T, the PPP concessionaire. This well-coordinated institutional framework ensures that a consistent vision, strategy, and policy facilitates various steps of the project, such as provision of state land, acquisition of land, and permission for land use changes. And the Chief Minister of Andhra Pradesh provides strong leadership and political support.
model of long-term urban finance and development across the Tokyo Metropolitan Area.

Transit agencies are typically established as public sector entities in cities of both developed and developing countries since urban transit on its own is seldom profitable enough. This is due in part to high land acquisition costs and competition with other transport modes, particularly automobiles. Even so, encouraging private entrepreneurship through different degrees of privatization in the provision of transit infrastructure and services could support such a public sector undertaking. In Hong Kong SAR, China, the MTR Corporation is highly entrepreneurial in exercising its R+P program, though the government as a beneficial owner keeps 76.7 percent of the MTR shares issued under the control of the Financial Secretary to ensure broader public interests. The privatization of the Japanese National Railways in 1987 brought a more business-oriented corporate culture and entrepreneurial business model, exemplified by large-scale private redevelopment of rail yard sites near strategic terminal stations.

In the portfolios of entrepreneurial transit agencies or private railway companies, real estate and other related business practices have accounted for more than one-third of their recurring profits over the last decade—38 percent between 2000 and 2012 for Hong Kong SAR, China’s, MTR Corporation and 34 percent between 2003 and 2013 for Tokyo’s Tokyu Corporation. The diversification of corporate portfolios also reveals that railway companies can be passenger service providers, real estate developers, and town planners through the implementation of development-based LVC in broader urban contexts. Indeed, high-profile railway agencies in progressive cities such as Hong Kong SAR, China; Tokyo; Washington, DC; Nanchang; and Hyderabad have accumulated knowledge by recruiting not only transport engineers, but also real estate experts and urban planners and designers.

The MTR Corporation is an example of an entrepreneurial transit agency with sufficient expertise to propose site-level layout plans in and around stations and control development parameters/design standards that maximize the accessibility benefits conferred by stations on a case-by-case basis. To assure the public interest in the private provision of infrastructure and services, the innovative public-private partnerships (PPPs) in cities of developing countries should clearly specify the obligations of private partners in each of the project phases. In Hong Kong SAR, China, and Tokyo, public requirements are also set up along with market incentives for entrepreneurial private entities to meet local community needs through the exercise of development-based LVC.

Clear, Fair, and Transparent Rules

The underlying principle of development-based LVC as practiced by Hong Kong SAR, China, and Tokyo is the joint creation and sharing of land value increment. Creating development opportunities among voluntary public-private contributors in a collaborative effort can generate additional values
and greater synergies. Thus, it is essential to establish clear and fair rules for sharing costs, benefits, and risks among stakeholders to ensure the long-term commitment of public agencies and private entities to deliver transit projects, promote transit-supportive activities, and maximize benefits in and around stations.

The rationale behind development-based LVC is incremental value creation and sharing among governments, transit agencies, developers, businesses, and residents in and around stations. This obviously differs from tax- or fee-based LVC capturing “windfalls” from private property owners, as practiced in North America and other parts of the world. Tokyo illustrates the need for some voluntary contributions to create greater development opportunities for both the public and private sectors. So, in adapting development-based LVC for local contexts of the developing world, the rules for sharing costs, benefits, and risks must support the collaborative actions of multiple stakeholders.

The rules should be clear. In Hong Kong SAR, China, for example, the MTR Corporation’s R+P model offers three options for benefit sharing to private developers: profits in agreed proportions from the sale or lease of properties, assets in kind, and up-front payments from developers. The case-by-case arrangements are made according to development locations and market conditions, but rules of thumb make it easier for developers to work with the MTR Corporation on more complex and higher risk mixed-use development projects for greater returns on investment around stations. The government has also reaped substantial rewards through the transfers of development rights to the MTR Corporation, which can be shared with multiple departments and agencies for other social welfare programs.

The rules must be fair and transparent. As in Delhi, the land granted exclusively to a transit agency for development-based LVC is likely to produce intergovernmental conflicts of interest in capital cities with complex multilayered governance structures, unless other agencies can also obtain some development benefits in proportion to their resource contribution. To establish a win-win relationship among stakeholders, the innovative PPP scheme in Hyderabad attempts to ensure that the rules for sharing costs, benefits, and risks are adhered to by clearly specifying the obligations of government agencies and a private partner in the concession agreement.

**Key Instruments**

Policymakers and practitioners need to understand the basic features of various instruments and adopt appropriate combinations of development-based LVC techniques for the landholdings, stakeholders, periods, scales, and localities in their cities. Among the various instruments, land readjustment and urban redevelopment financing schemes—through the inclusive process of land resource allocation and urban planning—are particularly important for cities with a market freehold system.
Cities under a state leasehold system can generally use development rights sales with public requirements, as well as development incentives, to achieve their planning objectives. Cities in developing countries—such as China—have limited experience in property development in conjunction with transit investment. As a consequence, disproportionately large-scale layout plans have sometimes been adopted in station catchment areas. To set up realistic site parameters and attain intended spatial outcomes around stations, the MTR Corporation in Hong Kong SAR, China, maintains staff expertise in property development and town planning and has updated the property market profiles since the 1980s. These capacity building efforts can be seen as steps for adopting development-based LVC techniques in the developing world.

Cities under a market freehold system may be able to auction off public land with development conditions for public interests as well as development incentives for developers. In so doing, government agencies can raise up-front capital for infrastructure development, but they do not generate recurring revenues for operation and maintenance activities. Rail yard redevelopment in Tokyo and London shows that either local development agencies or private railway corporations should remain as stakeholders to directly control the public domain and sustain property management incomes in and around station facilities.

Land readjustment can efficiently assemble the rights of way for guided transit extension projects and simultaneously promote transit-supportive property development around new stations (mainly in suburban areas) if all landholders agree. Similarly, inclusive urban redevelopment schemes should become available with sufficient market incentives to consolidate private land parcels in target built-up urban areas, and create development opportunities in and around existing underused stations. Adopting inclusive instruments in developing countries requires entrepreneurial transit agencies to engage in lengthy negotiation processes, acquire knowledge about the options, and establish close relationships with multiple local stakeholders. The multiple development experiences in Tokyo highlight the need for active involvement and commitment of major landholders—who are often large real estate developers as well—to create greater development opportunities and maximize the land value added by transit investment.

FAR distribution requires special attention as it is associated with development rights sales, land readjustment projects, and inclusive redevelopment schemes. FARs can be used as a market incentive to achieve multiple policy objectives. These include the provision of infrastructure and services, public open space and amenities, affordable housing units, and mixed land uses in private development packages or urban regeneration districts near target stations.

The sale of tradable air rights can raise up-front cash for cities in developing countries where local governments face increased public debt and acute land constraints. But New York and São Paulo reveal that it is very
difficult to estimate the value of air rights and to control land use parameters that could directly result in transit-supportive urban forms through market-based air rights transfers.

**Challenges and Risks**

Development-based LVC is a powerful financing and planning apparatus, unlocking unexplored land value to finance transit and promote transit-oriented development, but the risks of overreliance, corruption, and gentrification should be carefully addressed.

**Overreliance**

Overreliance on development-based LVC exposes municipalities and transit companies to excessive risk in real estate markets. While a robust real estate market and rising land prices are good for development-based LVC, both governments and transit agencies should adopt sound funding strategies and financial management, especially when property markets indicate excessive speculation. Given the unpredictability of the real estate market, municipalities and transit companies should estimate the revenue to be generated from development-based LVC schemes based on cautious and realistic assumptions, taking market trends into account. But in the face of rapid urbanization, transit investment cannot wait for the market. So, governments should prepare contingent plans in case revenues are lower than projected—preparing alternative funding sources or adjusting the sequence of investments based on technical and economic consideration.

**Corruption**

In general, the perception of land transfers from the public to private sector is negative among citizens in many developing countries because of a lack of transparency. For this reason, governments or transit companies often find it difficult to secure public support for development-based LVC, especially from those living in the targeted property development areas. To secure public support, governments should raise public awareness of the chosen scheme and its objectives, principles, rules, and regulations. It is also important for governments to involve civil society organizations in front-end planning and postproject development activities.

Governments should also introduce a transparent monitoring and recording system for development-based LVC transactions. Stakeholders and citizens should have access to information on how the private development partner has been selected, what are the projected actual revenues, and how the revenues will be used. Probably the most important way to prevent potential corruption is to require that transactions be at the market prices based on independent assessment. For example, in Hong Kong SAR, China, the land price assessed by the government is not arbitrary—it is a market price based on independent, highly sophisticated land valuation principles.
and practices. Transparent information systems will also help governments, transit agencies, and developers prepare future development-based LVC schemes, by making the relevant market data available for them.

**Gentrification**

Land prices in and around transit stations typically rise, often displacing low-income households. But transit-oriented development should not just create economically efficient and environmentally friendly urban spaces. It should also address urban poverty and deprivation. Where possible, city authorities should pursue affordable housing and provide developers the incentives to ensure that affordable housing is built close to transit stops. A FAR density bonus for constructing social housing is such an incentive and can be built into development-based LVC agreements.

**Roadmap for Development-Based LVC Implementation through a Gradual Approach**

Development-based LVC is a complex operation where various public and private stakeholders jointly maximize and share increments in land value around transit station areas, exploring the accessibility and agglomeration benefits of transit investment. It requires favorable macro conditions, a strategic vision, a supportive regulatory and institutional framework, and considerable expertise. Its adoption and implementation depend on the conditions and needs of each city. The roadmap for development-based LVC implementation shows the critical decisions and steps for governments and their transit agencies in designing and implementing development-based LVC—and the factors related to their decisions and actions (figure O.3).

Adapting and implementing development-based LVC requires consistent policies, a strong institutional framework, a clear and transparent regulatory framework, strong planning and financial management, effective design, and efficient property management. Many policymakers and practitioners likely feel that what Hong Kong SAR, China’s, MTR Corporation and Japanese railway companies have done is unmanageable in developing countries. But both organizations developed expertise over many years, through trial and error. Other policymakers and practitioners might hesitate to adopt development-based LVC schemes because of the lack of available lands or the difficulty in acquiring them. Even in these situations, however, transit agencies can explore the possibilities for their own land, such as underground or above-station areas or depots, just as Nanchang Metro and Hyderabad Metro are doing. On land under their control, municipalities or transit agencies could start with a simple development-based LVC property development such as a single tower office building above a transit station. They could next develop a mixed-use complex, possibly with private developers. And they could eventually apply land readjustment or urban redevelopment schemes to develop areas adjacent to transit stations owned by
private owners. To do this, the national or any upper-level government may need to adjust the regulations for railway properties to allow their commercial development. The key is to take incremental steps that make sense for each municipality and to leverage internal and local assets.

**What International Development Financial Institutions Can Do**

At the 2012 Rio+20 Conference, international development financial institutions including the World Bank announced a joint commitment to provide more than $175 billion in loans and grants to develop sustainable transport systems in developing countries over the coming decade. While encouraging this commitment, it can cover only a fraction of total urban transit investment needs. For example, the total financial needs (for investment, operation, and maintenance) for the next two decades in Latin America are estimated at $308 billion (Ardila-Gomez, Ortegón, and Rubiano forthcoming). Given this financial gap, international development financial
institutions can help national and local governments develop policies and institutional capacities to tap financial resources other than public sources, through unconventional financial and project development schemes. They could also help countries develop their institutional and regulatory frameworks and implementation capacities. And they could finance prototype projects to demonstrate the effectiveness of development-based LVC. Given the expertise needed for development-based LVC implementation, they should collaborate with experienced transit companies like Hong Kong SAR, China’s, MTR Corporation and various Japanese railway companies. The institutional support also requires “bridge financing,” which allows transit agencies and their partner developers to start construction before development-based LVC revenues begin to flow.

Conclusion

High-quality transit is indispensable for sustainable urban development. Well-integrated transit and land use fosters cities’ economic competitiveness, environmental sustainability, and social equity. More specifically, transit-oriented development—which creates articulated densities around transit hubs by locating amenities, employment, retail, and housing in close proximity—is one of the most effective ways to achieve sustainable urban development. Properties in well-designed areas gain a price premium thanks to their accessibility and agglomeration benefits. Collaborative efforts of municipalities, transit agencies, developers, landowners, and communities can maximize this premium. In this joint value-creating exercise, municipalities and transit agencies can contribute significantly to value creation either through zoning changes (FARs and land use) or through transit investment. And by adapting various development-based LVC schemes in their respective local context, they can recoup some of their transit investment, operation, and maintenance costs.

The rapid population increase and robust economic growth in rapidly growing cities in developing countries, particularly in middle-income countries, are certainly favorable for development-based LVC. Regardless of diverse political, institutional, and regulatory frameworks, regardless of different economic development stages and financial positions, and regardless of state leasehold or market freehold systems, all cities are endowed with invaluable land resources that have made them what they are. Policy makers, government officials, transit practitioners, developers, landowners, and citizens can together decide their cities’ future—whether they continue to let cars dominate their places or whether they reclaim those places for the benefit of society. To reverse unsustainable development trajectories caused by rapid motorization, cities can unlock unexplored land values to finance transit investments and promote transit-oriented development for the well-being of people today and for their sustainable future.
References


PART I

Introduction
CHAPTER 1
Development-Based Land Value Capture for Financing Transit-Oriented Development

As cities in developing countries expand rapidly, their sprawl brings traffic congestion, air pollution, greenhouse gas emissions, poor use of energy and time, and socially unequal accessibility. Many of them have therefore turned to transit systems, yet costs of investment, as well as of operation and maintenance (O&M), are high and often beyond their fiscal means, even though per capita economic costs of transit may be lower than that of private cars. And so fiscal constraints have boosted interest in new sources of revenue, including “capturing” the increase in land value created by investing in transit systems through, for example, development-based land value capture (LVC). This approach seems to have strong potential, not only to raise funds for investing in transit, but also to guide sustainable urban development, leveraging synergies with transit-oriented development (TOD).

The objective of this book is to provide these cities with strategies and methods for applying development-based LVC for transit and TOD-related investments, based on lessons learned primarily from the world-class transit systems of Hong Kong SAR, China, and Tokyo and from other cities in developed and developing countries alike.

Car-Dependent Urban Development in the Developing World

The 21st century is the century of cities. More than half the world’s people, or 54 percent of the world’s population (UN Department of Economic and Social Affairs 2014), reside in urban areas, and 7 of every 10 people will live in cities by 2050, with about 90 percent of the growth in developing countries (UN-Habitat 2013). The urban areas in developing countries newly built in 2000–30 will equal the total built-up urban area worldwide in 2000 (Angel, Sheppard, and Civco 2005).
Cities globally generate about 75 percent of gross domestic product (World Bank 2009), but while urbanization is an engine of growth, it also has socioeconomic and environmental costs. For example, cities globally consume about 67 percent of energy and account for about 70 percent of greenhouse gas emissions. Due to the rapid urban population increase, one-third of urbanites are living in slums (UN-Habitat 2010); their number is projected to hit 2 billion by 2025 (UN-Habitat 2003).

The problems of urbanization caused by car-dependent urban development or “urban sprawl”—such as congestion, air pollution, greenhouse gas emissions, lengthy commutes, and socially unequal access to various urban services—are mounting in the developing world’s fast-growing cities. Enrique Peñalosa, former mayor of Bogotá, Colombia, has said that “Transport differs from other problems developing societies face, because it gets worse rather than better with economic development” (Peñalosa 2002). Essentially, motorization in developing countries accelerates with economic growth—as wealth increases, people shift from walking to bicycling to riding motorbikes and to driving cars. By 2050, China is projected to have 900 million motor vehicles, or more than the total number in the world a few years ago (Fulton and Cazzola 2008).

Recognizing the problems of car-dependent urban development, many cities in developing countries have started to develop mass transit systems such as bus rapid transit (BRT), light railways, and metrorail. In particular, the BRT approach first applied in Curitiba, Brazil, is gaining popularity among many secondary cities in the developing world due to its relatively low cost and short period of construction relative to rail transit. However, although BRT’s capital costs are a fraction of rail transit’s, they are still a financial burden for many cities. For example, after the success of TransMilenio BRT in Bogotá, the Colombian government supported the construction of BRTs in several secondary cities such as Barranquilla, Cali, and Cartagena, subsidizing 70 percent of the capital costs. Most cities cannot, however, cover BRTs’ O&M costs simply with fare-box receipts. Policymakers where the majority of urbanites are poor have little room for cost recovery, as seen in the 2013 unrest in São Paulo and Rio de Janeiro in Brazil, which was triggered by the government’s decision to increase transit fares. They also have little capacity to subsidize transit costs due to other funding demands.

As these cities continue to grow, the next transit systems, such as metros and suburban railways, which are extremely capital intensive, need to meet ever-increasing traffic demand. While comprehensive data on worldwide metro construction costs are scarce, metro construction costs seem to range from $43 million a kilometer (Seoul Subway Line 9) to $600 million a kilometer (Singapore Thomson MRT Line). And beyond these costs are high O&M costs, often exceeding cities’ fiscal means. Transit investment requires long-term financing, but the financing schemes are rarely available in developing countries.

These constraints have stimulated interest in new revenue sources, including capturing the increase in land value created by transit investment. In fact,
a few mega- and large cities in Asia such as Hong Kong SAR, China; the Tokyo metropolitan area; the Osaka-Kobe metropolitan areas; and Singapore have either fully or partly financed transit investment costs (and sometimes some O&M costs) by capturing the land value increase attributable to transit investment in corridor precincts or station areas (or both) for a long time (Murakami 2012; Cervero and Murakami 2009; Cervero 1998).

**Development-Based LVC as a Strategic Financing and Planning Apparatus for Transit and TOD-Related Investments**

LVC is defined in this book as a public financing method by which governments:

- Trigger an increase in land values via regulatory decisions, such as a change in land use or floor area ratio (FAR), or infrastructure investments, such as transit.
- Institute a process to share this land value increment by capturing part or all of the change.
- Use LVC proceeds to finance infrastructure investments, such as transit and TOD-related investment (box 1.1); fund any other improvements required to offset impacts related to the changes, such as densification; and implement public policies to promote social equity, such as provision of affordable housing to alleviate shortages and offset potential gentrification.

LVC instruments vary widely and have been applied by local governments and related agencies in different parts of the world. They can be classified into two major types: tax- or fee-based and nontax- or nonfee-based—what we call “development-based LVC.”

Tax- or fee-based instruments capture land value increases through, for example, property taxes, betterment charges, special assessments, and tax increment financing. In contrast, development-based LVC instruments capture these increments through land transactions such as selling or leasing land, development rights, and air rights; making land readjustments; and redeveloping urban areas. (More complete definitions of some LVC instruments are in chapter 2.)

Development-based LVC has the following advantages over tax- or fee-based LVC in financing transit and TOD-related investments:

- It has greater potential to finance capital-intensive transit or TOD-related investments without major fiscal distortions or public opposition to additional taxes or fees.
- It can generate not only direct revenues from land value increases attributed to transit investments but also more sustainable long-term revenues from properties (such as retail shops, leisure facilities, parking, and residential buildings to be developed around station areas) and increased transit ridership due to TOD.
**Box 1.1 What is transit-oriented development?**

Transit-oriented development (TOD) has two main characteristics:

- Proximity to and a functional relationship with transit stations and terminals, with service provision by high-quality public transit (such as metro and bus rapid transit).
- Compact, dense, mixed-use buildings and neighborhoods that are designed to encourage walking, cycling, and use of public transit by residents, employees, shoppers, and visitors.

The ingredients of successful TOD include strategic (macro-) and design (micro-) elements such as a strong development climate and master plans for multiuse, high-intensity developments supported by implementation plans.

They also include investments that promote:

- Easy and direct pedestrian, bicycle, and public transit access (figure B1.1.1)
- Good signage and a pleasant environment to attract substantial pedestrian flows
- Substantial regional accessibility to major job and activity centers
- Short, direct connections between transport modes and transit facilities
- Bicycle lanes and parking facilities that feed stations
- Attractive facilities that are well integrated with the surroundings (such as public spaces and street furniture)
- Safe and secure designs, including adequate lighting
- Effective parking management around stations
- Environmentally friendly technology, such as shared fleets of alternative (electric) vehicles in neighborhoods

**Figure B1.1.1 Key features of the eco-block concept**

Source: Fraker 2009.

*Note: BRT = bus rapid transit. The eco-block concept maximizes pedestrian access to transit stations. It is illustrated here using a location in China.*
Taxpayers often contest the coverage and amount of tax- or fee-based LVC instruments because the definition of benefits created by public intervention is often vague, the accuracy of the estimated increment is often challenged, and calculation methods are not well defined. As development-based LVC involves transactions of land, development rights, or air rights whose values have risen due to public investment or regulatory change, it establishes a clearer linkage between value creation and capture. Also, under development-based LVC the land value increment is calculated from a method that the stakeholders have agreed on consensually.

It has a much better chance of administratively working well in places with inadequate property taxes (for example, outdated cadasters or weak value assessment capacity), as in most cities in developing countries.

Governments can explore development-based LVC not only for infrastructure financing but also for urban planning and public policy. Ideally, it should promote cities’ economic competitiveness, environmental sustainability, and social equity:

- By changing land use regulations (by, for example, granting higher FARs and converting single land use into mixed land use), governments can develop articulated densities in station areas for diverse uses while increasing development-based LVC revenues (as higher FARs and mixed land use generally raise property values).
- By using development-based LVC revenues for TOD investments in station areas (such as parks, street lights, bike lanes, and pedestrian sidewalks), governments, transit agencies, developers, landowners, and communities can jointly develop efficient, attractive, and safe public places in TOD areas. Development of such prime public spaces, in turn, increases property values in TOD areas.
- In exchange for bonus FARs or other regulatory incentives, governments can require developers to provide social facilities, such as affordable housing units, daycare centers, and green spaces.

The authors are not denying the usefulness of tax- or fee-based LVC, as it has its own advantages. For instance, the revenues generated from property taxes can be sustainable, as collection does not deplete finite land resources. Moreover, using one category of LVC does not preclude using another. With a range of objectives, regulative and administrative feasibility, and political acceptability of public infrastructure finance, these LVC instruments can be applied separately, or together, to suit countries’ and cities’ own conditions.

Objectives, Methods, and Readership

This book is intended to extend the authors’ publication “Transforming Cities with Transit: Transit and Land Use Integration for Sustainable Urban
Development” (Suzuki, Cervero, and Iuchi 2013). In that publication, the authors concluded that integrating transit and land use—which can be achieved through a combination of TOD and LVC—is one of the most important strategic initiatives for developing more sustainable urban development. Thus, this book revisits LVC as a powerful financing and planning apparatus to promote such development, leveraging synergies between transit and TOD-related investments.

A more specific objective of this book is to provide cities in developing countries with strategies and practical methods for adapting development-based LVC, based on the experiences of Hong Kong SAR, China, and the Tokyo metropolitan area, as well as other cities in developed and developing countries. While the authors analyzed mainly metros, development-based LVC can be applied to different types of “fixed-guideway transit” (BRT, light railways, monorail, metro, urban rail), even though their economic and financial impacts differ by type: larger and nonreversible transit investments tend to have higher impacts. Given the wide range of conditions of developing countries’ cities, this book does not aim to generate a single standard model but rather to identify key enabling factors for development-based LVC adaptation, to introduce these to policymakers and practitioners, and then to encourage them to develop their own tailor-made development-based LVC schemes.

This study combined secondary source data and information review with in-depth field research on case study cities and projects. It first reviewed the experiences of development-based LVC mechanisms in transit investments in Hong Kong SAR, China, and the Tokyo metropolitan area, both of which are very good models for developing countries. Both areas have a long history of applying development-based LVC as a strategic financial and planning apparatus for large-scale transit and TOD-related investments. The Hong Kong SAR, China, case represents a development-based LVC mechanism under state leasehold, the Tokyo case under market freehold. The research also reviewed developed-country cities in other continents—New York City and Washington, DC, in the United States and London in the United Kingdom. Looking at several transit investment projects (including station areas funded under development-based LVC), the study analyzed historical and socioeconomic backgrounds, urban context, legal and regulatory systems (including planning systems and institutional framework and capacity), financial mechanisms, methods of LVC, and individual project cases.

Second, to make the recommendations relevant to realities in developing countries, the study investigated three transit project cases—Nanchang in China and Delhi and Hyderabad in India—using the same research framework applied to the cities in developed countries (to the extent possible). Background papers on the case cities were prepared by national consultants, except for Nanchang, China, due to availability of data and information collected for the World Bank’s lending operations.
These two developing countries are large, rapidly growing middle-income countries with sizable transit investments. China has a state leasehold system, India a market freehold system. Nanchang is applying a development-based LVC scheme for its new metro system, with financial and technical support from the World Bank. Two cities in India have also used development-based LVC, learning from the experiences of Hong Kong SAR, China, and Tokyo. The capital city, Delhi, partly financed its metro system using development-based LVC, but its metro agency has faced regulatory and institutional constraints in implementing it even with strong backing from the national government. Hyderabad is constructing new metro lines under public-private partnerships in which development-based LVC is important.

São Paulo, Brazil, was also studied, because of high potential for applying an innovative scheme of air rights sales, called CEPACs (Certificates of Additional Construction Potential), to transit and TOD-related investments, even if CEPACs have rarely been applied to these investments so far.

In selecting all these case studies, the authors also considered the demands of the World Bank’s operational staff, as they hope that this book will contribute to applying development-based LVC to transit and TOD-related investments in their client countries.

The concluding sections of the chapters mostly highlight and distill the key findings and lessons learned for policymakers, planners, and practitioners.

This book should interest a wide and diverse readership, including mayors, city council members, national and local policymakers, urban and transportation planners, transit agency officials, developers, local financiers and investors, development financial institutions, and others involved in transit and TOD-related projects in rapidly growing and motorizing cities in the developing world.

**Development Finance Context**

Tax- or fee-based LVC instruments have already been well explained in many academic papers and government reports. A few researchers have documented development-based LVC cases, but the information remains scattered and has not been evaluated within a coherent framework focusing on applying it to transit-related investments, and even less so to fast-growing cities in developing countries. Further, international development financial institutions (DFIs) like the World Bank have not yet seriously explored the international transfer of development-based LVC techniques across cities in developing countries, which are making sizable transit investments. Increasing demand for transit investments in DFIs’ operations provides excellent opportunities to help municipalities and transit companies in developing countries apply development-based LVC to their transit and TOD-related projects, to leverage DFIs’ financial support.
Structure of the Book

This book is divided into four parts: Overview; Part One—Introduction (chapters 1 and 2); Part Two—Lessons Learned from Global Development-Based Land Value Capture Practices (chapters 3, 4, and 5); and Part Three—Emerging Development-Based Land Value Capture Practices in Developing Countries (chapters 6, 7, and 8).

Major findings and recommendations are synthesized in the Overview. It presents key findings of the study and enabling factors for developing-country cities to establish their own development-based LVC schemes. After this chapter, chapter 2 presents the theory of transit-induced land capitalization and various LVC instruments used in different parts of the world.

In Part Two, chapter 3 describes the Rail Plus Property program of MTR Corporation Limited in Hong Kong SAR, China, as a successful development-based LVC practice under state leasehold. Chapter 4 introduces inclusive and diverse schemes involving multiple stakeholders in the Tokyo metropolitan area as an example of successful development-based LVC practices under market freehold. Chapter 5 highlights such practices in the United States—New York City and Washington, DC—and in the United Kingdom—London.

In Part Three, chapter 6 reviews development-based LVC practices associated with Nanchang’s new metro line. Chapter 7 analyzes the institutional and regulatory frameworks that affect the performance of LVC schemes in metro projects in Delhi and Hyderabad, India. Chapter 8 discusses the application of air rights sales in São Paulo, Brazil, highlighting innovations and challenges and their potential for financing transit and TOD-related projects.

Notes

1. The data vary depending on sources and methodologies. These are from the International Energy Agency.
2. Upgrading the transit system (such as BRT to metro on the same route) does not easily occur because of problems of “lock in”—once a technology is adopted, it is hard to change it due to institutional resistance and political inertia, beyond a weak fiscal capacity.
3. According to a report on selected metro projects posted on June 3, 2013, to the Pedestrian Observation website (http://pedestrianobservations.wordpress.com/2013/06/03/comparative-subway-construction-costs-revised/).
4. However, governments as well as their public transport agencies undertake LVC. In a still wider definition of LVC, public and private transit agencies can recoup the land value increase created by their transit investments regardless of ownership.
5. In general, the economic and financial impacts of metro investment are higher than those of BRT as BRT lines are reversible.
6. See, for example, “Tax Increment Financing: A Tool for Local Economic Development” (Dye and Merriman 2006); “Infrastructure Financing Options for Transit-Oriented Development” (U.S. Environmental Protection Agency 2013); and “Unlocking Land Values to Finance Urban Infrastructure” (Peterson 2009).

References


CHAPTER 2
Theory of Land Value Capture and Its Instruments

Many cities around the world are facing fiscal stress. One perennial problem is the disagreement between governments and their citizens on the taxes and fees the latter should pay for public services. Attempts by governments to raise them to cover the costs of public infrastructure and local services often face public opposition, as in Brazil in 2013. Fiscal challenges have stimulated governments’ interest in nontax or nonfee revenue sources, such as capture of land value increments created by public infrastructure investments to defray the costs of providing public services. Tapping into publicly created land value increment can be an efficient way to allocate resources by exploiting positive externalities—or windfalls. It is also rational because landholders who have capital gains from these windfalls should partly cover public costs under the “beneficiary pays” principle.

This chapter introduces the theory of land value capture (LVC), particularly that of transit-induced land capitalization and associated empirical evidence. Within the transit finance framework, LVC hinges on accessibility and agglomeration benefits of transit infrastructure investment along with transit-oriented development (TOD), which in turn get capitalized into land prices. Since TOD can also boost such benefits, governments and transit agencies could use some of the LVC-generated revenue for TOD-related investments, ideally increasing overall LVC-related revenues. This chapter also presents the features of major LVC instruments, some of which are further discussed in the case studies in later chapters.

Rationale for Land Value Capture (LVC)

LVC is an idea dating back to David Ricardo (1821) and to Henry George (1879). It is founded on the principle that land value is determined not only
by its intrinsic value and private investment but also by other external factors including changes in land use regulations, public investment in infrastructure and local services, and general population and economic growth (figure 2.1). There seems to be a consensus among scholars and development institutions like the United Nations (UN 1976) that “the beneficiaries of the public investments or the public decisions that increase their land values should partly cover public investment costs or return their benefit to the public.”

**Transit-Induced Land Capitalization**

LVC hinges on land price increases around transit stations or along transit corridors. Yet transit investment alone does not always cause land price appreciation. LVC is feasible only if external economic benefits of transit investment are capitalized into nearby land under prevailing market conditions and transit-supportive public policies. This section, therefore, introduces the theory of transit-induced land capitalization, its empirical evidence, and factors other than transit investment that may influence the land values of the transit station areas or corridors.

*Figure 2.1 Land values and their attribution*

The government, on behalf of the general public, should keep this portion of the land value.

Public service providers should capture this portion of the increment to cover the costs of public infrastructure and local service provision.

Private land owners should profit from this portion of the increment.

Land buyers (or lessees) pay sellers (lessors) to obtain the property rights of land.

*Source: Adapted from Hong and Brubaker 2010.*
Chapter 2: Theory of Land Value Capture and Its Instruments

Theory of Transit-Induced Land Capitalization

The impact of transport investment on land value has long been debated, due in large part to the complex mechanism of transit-induced capitalization under differing urban conditions. Conceptually, accessibility and productivity increases are key external economic gains from transport investment, which are capitalized into land values near transit facilities.

**Accessibility benefits.** Accessibility can be defined as the ability to reach economic resources and social opportunities (Hansen 1959; Ingram 1971; Wachs and Kumagai 1973). This means that the degree of access is determined by a combination of travel congestion and activity location in cities and regions. Under this definition, contemporary urban planning attempts to coordinate locations between activities for proximity, whereas conventional transport engineering and economics tend to maximize speeds between activities for mobility (Levine and others 2012; Black, Paez, and Suthanaya 2002). The type of activities depends on each individual, household, or firm, so accessibility is often addressed from homes to workplaces, schools, shopping, and leisure sites. All other things equal, households and businesses prefer to locate their houses, shops, offices, and factories with wider travel “sheds” around higher accessibility nodes of urban and regional transport networks. These typically include transit stations, highway interchanges, and airport terminals in cities’ key locations (Giuliano 2004). Without negative externalities from transport facilities (such as congestion, noise, and air pollution), willingness to pay for higher accessibility locations could be revealed, as development density/land value increases in the proximity of nodes or development density/land price gradients from nodes in a bid-rent curve. In this sense accessibility can be regarded as a surrogate for measuring external economic benefits of transport investment (Banister and Berechman 2000).

**Agglomeration benefits.** In recent years, agglomeration benefits have been increasingly discussed in academic and policy circles (for example, Cervero 1995; Cervero, Aschauer, and Cambridge Systematic Inc. 1998; Chatman and Noland 2011; Graham 2007; UK Department for Transport 2005), though conceptually it is more elusive and indirect than accessibility benefits, and its mechanism is yet to be fully comprehended. Agglomeration economies generally address increases in economic productivity of, singly or combined, workers, firms, or cities, stemming from higher densities of economic and social activities that can be explained by locational advantages such as sharing production inputs, sharing infrastructure, sharing consumer services and amenities, matching labor pools to jobs, matching firms in production processes, and capturing knowledge spillovers through face-to-face communication. Some of these explanations may be strongly related to changes in accessibility, though others may not (Cervero, Aschauer, and Cambridge Systematic Inc. 1998; Chatman and Noland 2011). The net agglomeration benefit of transport investment alone is often questionable because of the double counting issue with cost-benefit analysis, which we do not deeply investigate in this book. Our work refers to the synergistic
agglomeration benefit of transit investment along with the provision of TOD-related infrastructure, which can be seen as transit-induced land capitalization beyond accessibility benefits.

**Empirical Evidence for Transit-Induced Land Capitalization**

Much of the last few decades’ literature draws on North American (especially U.S.) case studies (table 2.1). Many papers identified land premiums caused by transit investment in station areas (Lari and others 2009; Dunphy and others 2004; Smith and Gihring 2006; and other authors in table 2.1). However, researchers sometimes found a weak correlation between transit and land value, or even inverse correlations (Gatzlaff and Smith 1993; Medda 2011).

This variance is due partly to methodological differences and quality of data, but it could be more fundamentally explained as multiple trends in contemporary urbanization. One is the localization of the transit investment impact: research in U.S. and European cities indicates that transit investment impacts on land values have become more localized (micro-geographic) as cities and transport networks developed well. In particular, the highest impact can be found downtown (where knowledge- and service-based business entities, such as finance and insurance, real estate, and advanced business services, concentrate around high-accessibility transit facilities) rather than in suburban areas’ bedroom communities.

Yet some argue that local development effects of transit investment are likely to be redistributive rather than generative within cities and regions, though the net economic impacts of business relocation are not a zero-sum game for society as a whole (Cervero, Aschauer, and Cambridge Systematic Inc. 1998; Weisbrod and Weisbrod 1997; Murakami 2010). Another important finding is that the impact of transit investment on land value could be synergistic with TOD infrastructure provisions and supportive public policies under favorable market conditions (Duncan 2011; Cervero and Murakami 2009).

**Table 2.1 Summary of empirical findings of transit-induced land value capitalization**

<table>
<thead>
<tr>
<th>Author (date)</th>
<th>Location (United States unless otherwise flagged)</th>
<th>Dataset</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Armstrong and Rodriguez (2006)</td>
<td>Eastern Massachusetts</td>
<td>1,860 SFR</td>
<td>Properties within ~1/2 mile of commuter rail sell for a ~10% premium; each additional minute driving distance from the station associated with a 1.6% decline in price</td>
</tr>
<tr>
<td>Benjamin and Sirmans (1996)</td>
<td>Washington, DC</td>
<td>250 rent observations (July 1992) from 81 apartment complexes</td>
<td>Rent decreased 2.4–2.6% per tenth of a mile distance from the metro station</td>
</tr>
</tbody>
</table>
### Table 2.1 Summary of empirical findings of transit-induced land value capitalization (continued)

<table>
<thead>
<tr>
<th>Author (date)</th>
<th>Location (United States unless otherwise flagged)</th>
<th>Dataset</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bowes and Ihlanfeldt (2001)</td>
<td>Atlanta, GA</td>
<td>SFR sales from Atlanta region, 1991–94</td>
<td>More than a quarter mile from station: negative effects primarily restricted to low-income neighborhoods; positive direct effects quarter to three miles of station</td>
</tr>
<tr>
<td>Cervero and Duncan (2002)</td>
<td>Santa Clara County, CA</td>
<td>Metroscan* data from 1998–99; 1,197 observations</td>
<td>23% capitalization for typical commercial parcels near a light rail transit stop; 120%+ for commercial land in a business district within quarter of a mile of a commuter rail station</td>
</tr>
<tr>
<td>Cervero (1994)</td>
<td>Washington, DC, and Atlanta, GA</td>
<td>Five rail stations in both cities, 1978–89</td>
<td>Office rents near stations increased; joint developments added $3+/gross square foot to annual rents</td>
</tr>
<tr>
<td>Chen and others (1998)</td>
<td>Portland, OR</td>
<td>1992–94</td>
<td>LR has a positive effect (accessibility) and negative effect (nuisance) on SFR values; at 100 meters from stations, each additional meter results in $32.20 reduction in average home price</td>
</tr>
<tr>
<td>Dewees (1976)</td>
<td>Toronto, Canada</td>
<td>Sale prices of residential properties and description characteristics</td>
<td>$2,370 premium per hour of travel time saved for sites within 20 minutes (walking) of Bloor St.</td>
</tr>
<tr>
<td>Fejarang (1994)</td>
<td>Los Angeles, CA</td>
<td>1980–90</td>
<td>$31/square foot premium for properties within quarter of a mile of station</td>
</tr>
<tr>
<td>Gatzlaff and Smith (1993)</td>
<td>Miami, FL</td>
<td>Property sales, 1971–90 (912 observations)</td>
<td>Weak correlation between rail development and housing values; impact does not vary upon property distance from station but does vary across neighborhood types</td>
</tr>
<tr>
<td>Gu and Zheng (2008)</td>
<td>Beijing, China</td>
<td>New residential projects within 4 kilometers of No. 13; January 1999–September 2006</td>
<td>Housing prices higher by nearly 20% within 1,000 meters; encourages development intensity around stations</td>
</tr>
</tbody>
</table>
### Table 2.1 Summary of empirical findings of transit-induced land value capitalization

(continued)

<table>
<thead>
<tr>
<th>Author (date)</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Hess and Almeida (2007)</td>
<td>Buffalo, NY</td>
<td>2002 assessed value of properties (City of Buffalo, 1990–2000)</td>
<td>Average residential property values increased by an average of $2.31 for every foot closer to a rail station (geographic straight line) and $0.99 (network distance); homes within quarter of a mile of LR station can earn $1,300–$3,000 premium</td>
</tr>
<tr>
<td>Knaap and others (2001)</td>
<td>Washington County, OR</td>
<td>All sale transactions of vacant residential parcels within urban growth boundary, January 1992–August 1996 (1,537 observations)</td>
<td>Plans had positive effects on land values in proposed station areas; discouraged low-density housing, encouraged high-density TOD</td>
</tr>
<tr>
<td>Landis and others (1995)</td>
<td>San Diego, CA</td>
<td>Five City Study (California)</td>
<td>$272 increase in home sale price for every 100 meters closer to LR station; no effect for commercial properties</td>
</tr>
<tr>
<td>Landis and others (1995)</td>
<td>San Francisco, CA</td>
<td>Five City Study (California)</td>
<td>$51,000 sale discount for houses within 300 meters of train tracks</td>
</tr>
<tr>
<td>Lewis-Workman and Brod (1997)</td>
<td>Portland, OR; San Francisco, CA; New York</td>
<td>Portland: property tax rolls, 1995 cross sections; San Francisco: home sale prices 1.6 kilometer radius of station, 1984–96 sales in regression; New York: 18 years of sale data</td>
<td>Portland: $2.49 increase for every meter closer to rail, within 762–1,609 meters to transit; $760 (average) premium for homes 305 meters closer to transit; San Francisco: nonuser benefits account for 50% of observed premium, 1% increase in distance from Bay Area Rapid Transit reduces home prices by 0.22%; New York: $75 decline in home price for every meter from subway stations, $37,000 average home premium within subway station areas (as opposed to outside)</td>
</tr>
<tr>
<td>Lin and Hwang (2004)</td>
<td>Taipei, Taiwan, China</td>
<td>1993–95 (before subway); 1997–99 (after subway)</td>
<td>Subway opening significantly influences hedonic prices of floor space, building age, and distance from public facilities; second influence of system opening on hedonic price varies significantly according to different submarkets such as subway construction, location in city, position of property relative to subway stations, land use, zoning, and building type</td>
</tr>
</tbody>
</table>

(continued next page)
Table 2.1 Summary of empirical findings of transit-induced land value capitalization (continued)

<table>
<thead>
<tr>
<th>Author (date)</th>
<th>Location (United States unless otherwise flagged)</th>
<th>Dataset</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nelson (1992)</td>
<td>Atlanta, GA</td>
<td>Office commercial property sold in study area, 1980s–94 (30 sales)</td>
<td>Negative effect on home values in high-income areas, positive in lower; premium on property values in low-income areas ($0.96 per foot distance to station)</td>
</tr>
<tr>
<td>Weinberger (2001)</td>
<td>Santa Clara County, CA</td>
<td>Lease transactions, 1984–2000 (3,701 records)</td>
<td>Higher lease rate for properties within 0.8 kilometers of a rail station</td>
</tr>
<tr>
<td>Yankaya (2004)</td>
<td>Izmir, Turkey (subway)</td>
<td>December 2003–March 2004 (360 observations)</td>
<td>Proximity to subway stations cause higher property values due to accessibility and commuting reduction</td>
</tr>
</tbody>
</table>

Source: Adapted from Lari and others 2009.  
Note: LR = light rail; SFR = single family residential property; TOD = transit-oriented development.  
* Metroscan data encompass all real estate transactions that are recorded in country assessor offices.

Other Factors

Factors other than transit investment may influence land values in transit station areas or corridors, categorized under four heads, as now discussed. Those adapting LVC for transit and TOD-related investment financing should also consider these factors.

Macro Factors

- Population and economic growth: Both areas of growth are fundamental to creating demand for land with accessibility and agglomeration benefits. In the metropolitan context, we should observe both regional trends (the metropolitan area as a whole) and local trends (specific locations), as not all areas experience the same growth rate. These factors include different stages of economic development (such as deindustrialization, shifting from manufacturing to knowledge- and service-based industries) and emerging demographic patterns (such as international migration and population aging).
- Degree and pattern of urbanization: These are important to the potential impact of path-dependency, which may limit land value appreciation.
- Real estate: Transit can only enhance land values where market demand exists. Similar to population and economic growth, real estate has submarkets, according to differing uses (shops, offices, residential—single detached houses, apartments/condominiums, and so on) and different locations, and transit investment influences each submarket differently.
• Developing countries: Many cities, particularly in middle-income developing countries, have favorable macro conditions (strong economic growth and rapid population increase), leading to strong demand for land in prime locations with good accessibility.

Regulatory and Institutional Factors

• Land administration and availability of developable land (such as under leasehold or freehold systems).
• Regulations: Government planning regulations such as a floor area ratio limit and land use also influence land values. As accessibility and agglomeration benefits are appreciated differently by each real estate submarket, the government’s decision on land use also influences land values in transit station areas. Regulations on public parking supply and pricing also affect accessibility in transit station areas.
• Institutions: Competent local governments and transit agencies with strong planning capacity and real estate knowledge are critical to maximize land values with private developers. This factor includes the degree of privatization or private participation in transit investments, TODs, and LVC implementations.
• Developing countries: Few governments and transit agencies have either adequate regulatory frameworks or institutional capacity, and both are typically required to implement transit and TOD-related investments with LVC.

Transit Technologies, Networks, Alternatives, and Nuisance Factors

• Technologies: Heavy or metro rail usually has a bigger impact on land values than light rail or bus rapid transit as it provides greater accessibility benefits due to higher speeds and larger transit capacity than light rail or bus rapid transit (which often shares road space with automobiles).
• Networks: Transit networks—including connectivity with other transport modes—are important for accessibility. Hence, the larger the network, the greater the accessibility benefits. For example, the accessibility benefits of the well-connected metro system with 304 kilometers of lines serving 285 stations in Tokyo is much higher than that of the Porto Alegre metro system in Brazil with 44 kilometers serving only 22 stations. However, the incremental accessibility impact of transit on land values will gradually diminish as the impact becomes saturated and more redistributive over the entire network as it expands.
• Alternatives: Transit impact on land values is less when transit catchment areas have access to other competing transport modes. For example, San Francisco’s Bay Area Rapid Transit (BART) system had