PLAN AND DESIGN STRATEGIC DENSITY

INTEGRATED GUIDELINES FOR SUSTAINABLE NEIGHBOURHOOD DESIGN

Urban Morphology & Complex Systems Institute 2021

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PLAN AND DESIGN STRATEGIC DENSITY

INTRODUCTION

To many, density conjures up images of uncomfortable crowds and impenetrable high-rise towers. The neighbourhood approach challenges preconceived notions of density which is often portrayed by poorly defined and inadequately used spaces. It argues that density, done strategically, can contribute to making a more liveable community.

Medium high density (13,000 inhabitants per square kilometre) characterizes the most liveable cities and neighbourhoods. It features a good balance of residents and jobs, retail, education, and health, and up to 36% to 50% green open space. Sustainable density is the smart combination of these urban assets and not a figure number. The blend must be fine grain, highly intermingled and well designed.

Planning and designing strategic density relies on three main pillars.

DESIGN MIXED-USE GREEN DENSITY
PLAN WITH TRANSIT-ORIENTED DEVELOPMENT
PRIORITIZE WITH THE 3-VALUE FRAMEWORK

DESIGN MIXED-USE GREEN DENSITY

Misunderstandings about density lead to substantial incomprehension even among professionals. It should not be confused with crowding (people per room) or building bulk or coverage. Negative perceptions of density frequently come from a misrepresentation with what is not density. For instance, high-rise towers are not a dense urban form and are often four times less dense than a continuous, liveable, medium rise and green urban fabric like that of most European cities' historical centres[1]. Higher density does not imply building tall. Good design can achieve density by using various buildings types and amenities with medium height. Density does not mean building smaller residential units. Creative layout of volumes, light and outdoor areas can offer generous spaces at higher densities. With careful planning and design, density schemes create sustainable places with a range of housing types, excellent space standards and an attractive public realm.

[1] High residential density does not imply vertical urban forms. With 21,000 inhabitants per square kilometre (25,000 without 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 such as the 11th arrondissement have densities of 40,000 inhabitants per square kilometre – much higher than vertical building forms. The Modernist movement theoreticians, such as Le Corbusier, have invented high rise towers in the 1920s with the purpose of decreasing density with towers-in-a-park isolated in expansive empty land. The towers of the 1960s in Europe and the US and those of the 21st century in most fast-growing cities are low density developments in poorly defined spaces. This vertical growth is an inefficient form of land use where much urban land is empty or occupied by oversized road infrastructure. See Salat et al. 2011.

LOOKING AT URBAN LAND FROM A SUSTAINABLE DENSITY PERSPECTIVE

A crucial issue of unplanned growth in emerging cities is the lack of urbanized land to provide the basic needs of city life. Eighty percent of the Indian population resides in inadequate housing[2]. In a city like Mumbai, for instance, 8 million slum inhabitants live at 160,000 people/km^2 density with only 6.25 m^2 of land per person. Peaks of density reach half a million people/km^2 with very scarce land of 2m^2 per person for all the dwelling and urban functions. Even when residential density does not reach the extreme spikes of Indian cities, informal urbanization most often fails to provide land for basic city infrastructure such as streets, sewage, energy, education, healthcare and public open space.

Sustainable density can be addressed from a land and liveability perspective. Urban liveability is usually defined as the extent to which a city can satisfy the physical and psychological needs and demands of its residents. A density of around 12,500 people/km^2 is observed in the districts of the European cities that are ranked as the most liveable, such as Vienna, Geneva, Copenhagen[3] and in Malmö Bo01 Eco neighbourhood. These neighbourhoods offer 80 m^2 of land per capita for supporting the functions of urban life. UN Habitat[4] recommends a residential density of 15,000 people/km^2. This is also a density found in Asian liveable cities such as Tokyo, Osaka[5], and Seoul and in Hammarby Sjöstad Eco neighbourhood. Such density represents 66 m^2 of urban land per capita. These two benchmarks highlight the lack of land in Mumbai slums. Their inhabitants have 10 to 13 times less land than what would be necessary to achieve sustainability and liveability. Such a scarce land per capita prevents providing health, quality education, clean water and sanitation, decent work and economic growth in the neighbourhood. In cities, as detailed below, economic activities, amenities (such as health, education, cultural spaces) and institutions occupy about one quarter of the urban land; streets, gardens and public squares occupy about half of the urban land. Land is thus needed to meet housing needs but also economic activities (SDG 8) and to provide green and public spaces for healthy living (SDG 3). When land is too scarce, like in overcrowded informal settlements, basic needs beyond dwellings cannot be met.

Sustainable urbanization aims to provide decent dwellings for all within a physical framework of streets, affordable public transportation, energy, water, sewage infrastructure. Sustainable planning should strive to design density with the right mix of uses and spaces to create complete communities that allow meeting the SDGs. UN Habitat's work and the benchmarks of sustainable neighbourhoods explored further on in this chapter show that ideally:

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[2] India Ministry of Housing and Urban Affairs (MoHUA) 2020.

[3] Mercer 'Quality of living city ranking' ranks among global cities Vienna 1st, Zürich 2nd, Munich 3rd, Frankfurt 7th, Copenhagen 8th, Geneva 9th, Basel 10th. Globally, Vienna tops the ranking for the 10th year running. https://mobilityexchange.mercer.com/insights/quality-of-living-rankings
Vienna ranked also 1st most liveable city in 2018 survey of the Economist Intelligence Unit.
https://asia.nikkei.com/Economy/Asia-dominates-liveable-city-rankings-with-Tokyo-and-Osaka-in-top-10
Vienna also ranked 4th globally in the Economist Intelligence Unit Green City Index, while Copenhagen ranked 1st among European cities.
(Economist Intelligence Unit. 2011. *European Green City Index* https://eiuperspectives.economist.com/sustainability/european-green-city-index)

As shown further in this chapter, Vienna is one of the densest European cities. Its density in the residential area is 17,700 people/km^2 and 21,530 in the 6th district. Geneva density is 12,929 people/km^2. Copenhagen density in Vesterbrö is 13,688 people/km^2.

[4] UN Habitat 2015.

[5] Osaka ranked 3rd and Tokyo ranked 7th most liveable city in 2018 survey of the Economist Intelligence Unit.
https://asia.nikkei.com/Economy/Asia-dominates-liveable-city-rankings-with-Tokyo-and-Osaka-in-top-10
Osaka, Tokyo and Seoul are also rank high in the Economist Intelligence unit Green City Index.
(Economist Intelligence Unit. 2011. *Asian Green City Index*).

- Housing occupies about 25% of urban land.
- 25% is reserved for economic (jobs), retail, health, education, civic functions.
- 25% to 30% of urban land is dedicated to streets that support community life, retail activity, people movement, public transport.
- 20 to 25% of urban land is reserved for green or open space (squares, gardens and parks).

Sustainable residential and job density in mixed-use schemes brings people, employment, education, health, retail and activities, close and at walking distance. Population and job density must be high enough to encourage retail, services and a quality public realm at proximity of all homes. Areas that support walking and cycling for main mobility options need high levels of activity (density housing mixed with jobs and retail).

Sustainable density provides jobs and dwellings in the same communities. UN Habitat recommends 0.7 jobs per resident. Benchmarks at city scale often show a minimum of 0.5 jobs per resident leading to 1 job per active working population. This diminishes the burden of transportation costs on household budgets and reduces CO_2 emissions. A 160-ha district such as Paris 4th arrondissement presents a high job resident/ratio and many jobs available locally. This ensures that about three quarters of the active population living in the arrondissement work in the same district, a characteristic of most Paris arrondissements. Along with the excellent walkability provided by a highly connected and extensive public realm, this makes people move away from cars (three quarters of households don't own a car). Residents go to work utilizing public transport (63%), walking and cycling (18.4%). Only 6.5% use a car[6].

The benchmark of liveable cities and UN Habitat recommendations lead to two sustainable density scenarios. Both scenarios are equally sustainable and are found in Scandinavian eco-neighbourhoods. They illustrate that diverse ranges of density may be selected according to location and to accessibility. Scenario 1 would offer more open blocks and more open space. The most accessible locations would tend to have higher density, such as in scenario 2, but with careful urban design and in particular three-dimensional greening (green facades, green roofs, green terraces, sky gardens) they may achieve the same levels of environmental quality as the scenario 1.

Scenario 1

Scenario 1 envisions 12,500 people/km^2 and at least 6,500 jobs/km^2. This leads to 80 m^2 of urban land per capita with:

- 20 m^2 of land/capita for housing.
- 20 m^2 of land/capita for economic and social activities including jobs, hospitality, retail, schools, healthcare.
- 20 to 24 m^2 of land/capita for streets (25% to 30%).
- 16 m^2 to 20 m^2 of land/capita for public green spaces (9 m^2 minimum according to WHO) and public realm such as squares.

Housing space in liveable cities tends to offer 30 m^2 of floor space/people on average within urban blocks comprising 50% inner green spaces. Economic activities are accommodated in mixed-use areas along with dwellings. This density does not require high-rise constructions. Floor Area Ratio[7] (**FAR) of 3.75 and 4 to 5 floor buildings** is sufficient. These levels of density are achieved in Eco neighbourhoods such as Malmö in Sweden.

Scenario 2

Scenario 2 envisions density of 15,000 people/km^2 and at least 7,500 jobs/km^2. This is the density found at city scale in Seoul and Tokyo. It leads to 66 m^2 of urban land per capita with:

[6] Data source: INSEE. https://www.insee.fr/fr/statistiques/2011101?geo=COM-75104

[7] Floor area ratio (FAR) 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. It is often used as one of the regulations in city planning. The term can also refer to limits imposed on such a ratio through zoning.

- 16 m^2 of land/capita for housing.
- 16 m^2 of land/capita for economic and social activities including jobs, hospitality, retail, schools, healthcare.
- 16 m^2 to 20 m^2 of land/capita for streets (25% to 30%).
- 13 m^2 to 16 m^2 of land/capita for green spaces and public realm such as squares.

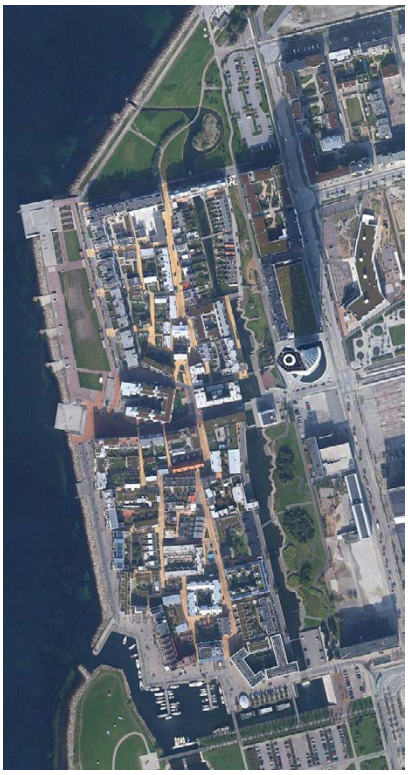
FAR is 4.7 with 5 to 6 floor buildings. Edge buildings can be higher and those inside the blocks can be lower. This is the density and urban fabric of Hammarby Sjöstad eco-neighbourhood in Sweden.

If greening the blocks, with 3D landscaping (green roofs and sky gardens) the overall green space can be 50% of the original plot of land in both scenarios.

LOOKING AT DENSITY FROM A GREEN PERSPECTIVE

Framing the project with the landscape and integrating green at all magnitudes – including at microscale – draws people and nature close together with on-site water treatment, food production, and other biological processes while moderating the microclimate.

Sustainable density is both a concentration of uses and urban vibrancy and an intensification of green open space at many scales. It incorporates ecological functions such as water, trees and green areas. Malmö Bo01, Hammarby Sjöstad in Sweden and Kampung admiralty in Singapore demonstrate that sustainable density can be attained while regreening between 50% and more than 100% of the original land. The gross area of Bo01 Mamö, for instance, is 18 ha without the water area. The population density is 122 people per ha (corresponding to 12,200 people/km^2). Over 70 buildings achieve a fine grain diversity of 3.2 buildings per ha. Mixing the plot sizes and architectural requirements so that the scale and character of the buildings differ on every block and weaving 50% green open spaces creates a green medium-high density. The variety and detail are outstanding with a mix of unit sizes and ownership types.



Bo01 Malmö in Sweden aerial view.

Green density in Auteuil, Paris, in a circle of radius 300 metres. Twenty-four thousand people/km^2 in a compact urban fabric intermingled with a variety of green spaces.

The benefits of density

Economic

- Increases productivity with agglomeration economies – economic density (jobs/km^2, GDP/km^2)
- Enhances economic viability of neighbourhoods. Dense developments can make local businesses more profitable.
- Decreases infrastructure costs per inhabitant.

Social

- Encourages positive social interaction and diversity.
- Strengthens the safety and opportunities for utilization of public spaces.
- Improves economic viability of and access to community services.
- Supports mixed uses
- Offers a breadth of facilities in a walk of 5 to 10 minutes.
- Enables more and better integrated affordable housing. The dwelling stock can more easily provide a wider range of types and tenure.

Transport

- Provides a customer base for efficient public transport
- Promotes cycling.
- Reduces car travel, parking demand and congestion.

Environmental

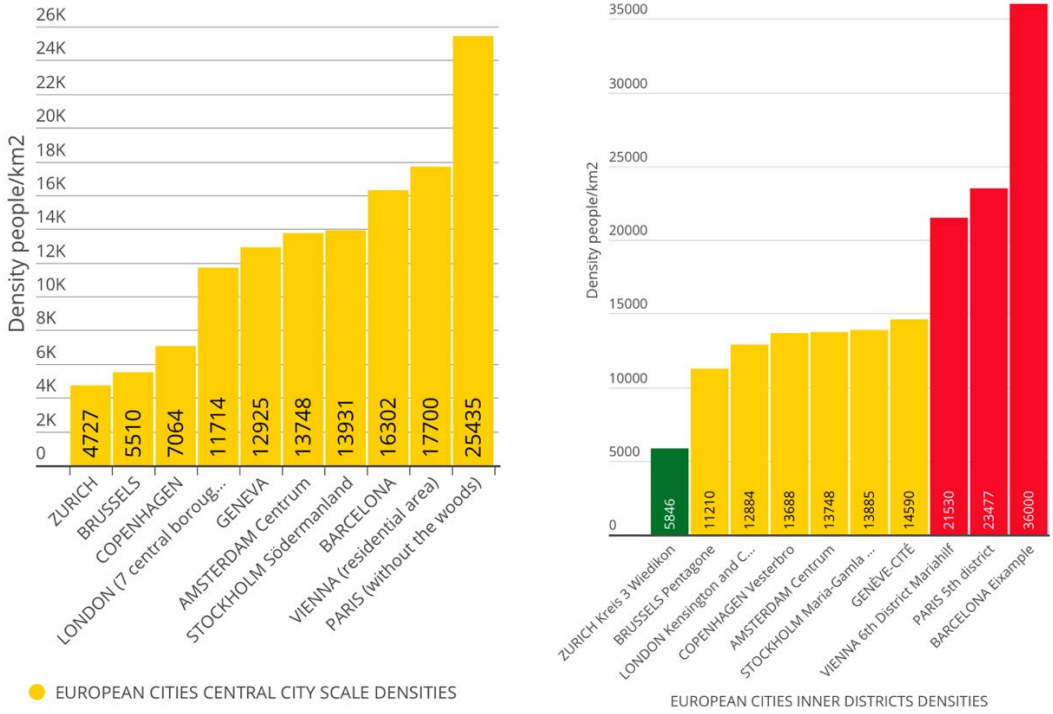
- Diminishes CO_2 emissions both for transportation and for thermal comfort energy.
- Increases opportunities for more efficient energy supply, including local renewable production and distribution networks.
- Decreases resource consumption and energy embodied in infrastructure.
- Generates less pollution.
- Preserves and helps fund maintenance of public open space.
- Reduces demand for development land – avoiding sprawl.
- Protects the countryside and landscape.

LIVEABLE DENSITY BENCHMARKS

The ten chosen cities for the following benchmark rank in the top 10 across several liveability indexes. The benchmark shows that sustainable green density usually ranges between 12,000 and 14,000 people/km^2 and that it can reach 24,000 people/km^2.

Two scales are explored.

- **Central city**. This scale corresponds to what makes the liveability, urban quality, and image of the city[8].
- **Inner districts.** These districts are similar in size (a few square kilometres). They comprise a highly stimulating mix of retail, offices, and residential with a good balance between them. They offer generous landscaped parks and a multiplicity of smaller open green spaces sprinkled across the urban fabric.



Density in selected liveable cities and districts. Source: Urban Morphology and Complex Systems Institute.

The following table shows how green high density looks like at district scale in increasing order of density.

[8] Attention has been paid to compare at the same scale. For instance, Paris, the 7 central boroughs of Inner London, Barcelona, Vienna (residential area), Zurich, Copenhagen have all an area between 85 and 100 km^2. Other city centres such as those of Amsterdam, Stockholm, Geneva, Brussels are significantly smaller but they present similar urban fabrics and levels of density as the larger city centres of global cities such as Paris or London.

	
Zurich 5,846 people/km^2	Brussels[9] 12,210 people/km^2
	
London Kensington and Chelsea[10] 12,884 people/km^2	Copenhagen Vesterbro[11] 13,688 people/km^2
	
Amsterdam Centrum[12] 13,748 people/km²	Stockholm Maria-Gamla Stan[13] 13,885 people/km²

[9] Photo: Jean-Pol Grandmont.
[10] Pembridge Square. Photo : ©Françoise Labbé.
[11] Photo: Leif Jørgensen.
[12] Photo: Martin Furtschegger.
[13] Mariakyrkan. Photo: Holger Ellgaard.

	
Genève-Cité[14] 14,590 people/km^2	Vienna Maria Hilf[15] 21,530 people/km^2
	
Paris 5th arrondissement[16] 23,477 people/km^2	Barcelona Eixample 36,000 people/km^2

DESIGN FINE GRAIN DENSITY

Density is not just a figure. Density is only one aspect of built form. Height, block size and building typology will all affect the character of an area and the perception of density. Well-designed density should interweave fine-grain built form, vibrant public realm, and high-quality green space. Average density targets and general standards (such as open space ratios, parking and highway geometry, for example) should not shape urban forms. Standards tend to produce blandness at the lowest common denominator. The sustainable approach of density is design-led and focuses on urban quality and good city form. Design considerations should carve urban forms; density should be only a measure of the end result, not a determinant of it.

Compact forms are the foundation of sustainable density. Traditional low- and medium-rise buildings are arranged in small blocks. They are developed around their perimeter. They contain generous green courtyards inside like in Amsterdam or in Hammarby Sjöstad. They weave built forms and open space, facades and trees. Interweaving mass and voids opens vistas and passages through blocks, with contrasts of light and shade, heat and coolness when a funnel accelerates a gentle breeze. High density in a medium height complex fabric offers this vibrant experience mixing buildings with nature. ’

[14] Photo: Alexey M.
[15] Vienna 6th district, Mariahilf Arik-Brauer-Haus, built in1991. © Bwag/Wikimedia
[16] Photo: Adrian Diez.

Green density in Pembridge Square, London. Photo: ©Françoise Labbé.

Schemes should pay attention to

- ***Context* –** Density needs to be context specific. The density must not necessarily be the same as that of the surroundings, but the new buildings must respect their neighbours in terms of scale, detailing, and mass.
- ***Design* –** Well-designed constructions with generous space standards and quality materials.
- **Public realm –** A public domain that is readable, convenient and stimulating.
- **Private outdoor space –** or high-quality common areas.
- **Parking –** Adopt adequate and appropriate parking levels to meet the needs of users without dominating or harming the outside environment.
- **Management –** Effective supervision including the formation of resident groups as trusts or associations in housing projects.

In many areas, an urban fabric composition with mid-rise, high-density buildings (4–5 floors) allows to create a variety of shapes that optimizes land development intensity while minimizing perceived density. To achieve the right form of density, urban designers should

- Design traditional perimeter blocks while ensuring that buildings, streets and places are human-sized.
- Moderate the mass of buildings. Break it into smaller units with permeability for pedestrian movement and cross-through vistas.
- Use high-quality landscaping to soften and enliven the perceptions of a place.

This urban fabric can be attractive, energy-efficient and mixed use, while

- Reducing the cost of acquiring land and site infrastructure.
- Establishing a robust urban structure that allows to change usage over time.
- Forming terraces or medium-rise apartments, the most profitable building form in housing.
- Increasing energy efficiency and orientation for passive solar gains.
- Providing lifetime homes easily adapted for the elderly or disabled.

CREATE A DENSITY GRADIENT

Density should not be uniform. It should be strategically distributed.

- **Diverse density gradient –** various mixes of density reflect the differences in lifestyles and trade-offs made by distinct social groups.
- **Density pyramid –** positioning of lower density on the project edges and higher density in the local centre with gradation of varied types. Shaping the built mass in a more formal way around a water or park boundary can also introduce contrast.
- **Green densification –** Adding dwellings and green spaces in the right place can improve the mix of functions, cool the urban fabric, and strengthen community identity.
- **Smart densification –** Small, precise interventions that capitalize on existing residual areas. The thoughtful planning of private and collective outdoor space can provide mediated access and visual contact with the street, and reflect distinct levels of privacy.

The density profile, gradient and form should be varied within the neighbourhood, according to location, to create a well balanced and ordered urban landscape. Many recent developments have flat and featureless density profiles. This is the product of imposed standards or density levels. The even distribution of the built mass irons out the density structure. Many current standards are mandatory measures rather than performance criteria. They command schemes designed to comply and obtain approval. The resulting projects do not have a distinctive identity. They waste land and infrastructure, and lead to car dependency.

Context should inform density. Developments should offer diverse mixes to cater for pluralistic social needs. A mix of heterogeneous density levels and uses reflects the variations in lifestyle and the trade-offs made by different groups. The space we want around our homes and near the central areas is, for instance, balanced against the price of real estate and commuting time. The establishment of socially mixed communities with diverse ways of life requires a blend of building types and layouts. This goal can be achieved by creating a pattern of fine-grained development plots and let the market mediate between distinct needs and aspirations while ensuring coherence and consistency by master planning.

The density profile must have a legible shape by increasing concentration around centres, public transport access points, parks and riverbanks. On large schemes, it is often useful to articulate different forms of housing, with a 'density pyramid'. This requires positioning of lower density on the project edges and higher density around and in the local centre, with gradation of intermediate types and sizes. This general approach can establish smaller 'hot spots', such as a higher-rise apartment building on a corner or a walkway. Shaping the built mass in a more formal manner around a water edge or a park can introduce counterpoint and create an urban promenade such as in Hammarby Sjöstad or Malmö. Density can frame a positive public realm with a contrast between formal public space and boulevards and more intimate and green areas within open blocks.

CASE STUDY: SCALES OF DENSITY IN HAMMARBY SJÖSTAD

Left. Hammarby Sjöstad aerial view. Right. Open composition of buildings facing the water. Photo: Photo: © Françoise Labbé.

Hammarby Sjöstad is a high-density district with an envisioned density of 15,000 people and 7,500 jobs per km2.

Among the key organizing principles of Hammarby Sjöstad is the diversity in the magnitudes of development. It varies from four- to five-story buildings along the Sickla Canal to six- to eight-story buildings along the main corridors. Taller structures facing the water are built in a classic urban style that complements the large-scale facilities and open water areas. 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, with development gradually downscaled toward the shorelines.

The moderate height of the houses and the spacious blocks allow for both wind-shielded and sunny inner courtyards. The open blocks offer ample possibilities to develop inviting common courtyard green. They facilitate small-scale cultivation in micro-garden plots or small greenhouses.

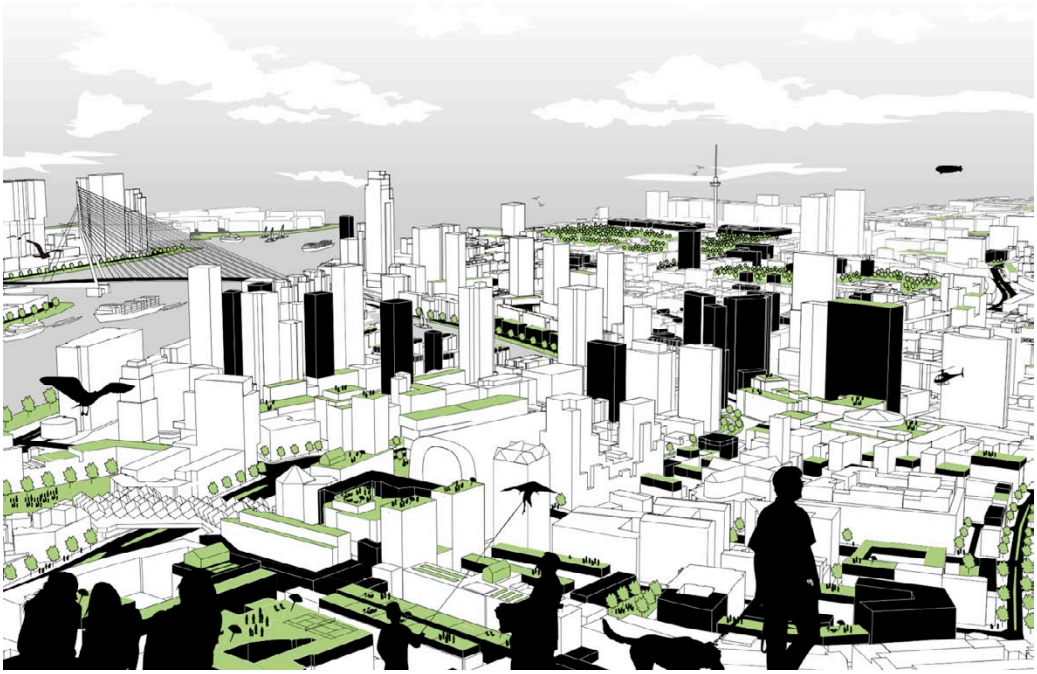
RECLAIM LOST LAND WITH INFILL

Contemporary cities are full of lost spaces. They are the leftover unstructured space at the base of high-rise towers; the surface parking lots that sever connections; the no-man's-land along the edges of freeways; the abandoned waterfronts, train yards, vacated military sites, and industrial complexes. Now major gaps disrupt the continuity of almost any city. They break pedestrian links between important destinations. Walking is frequently a disjointed, disorienting experience. A staggering percentage of urban land in modern American cities is devoted to the storage and movement of cars – in Los Angeles and Detroit as much as 75 to 80%[17]. Partly because of this, vast open areas without social purpose separate buildings. Streets, no longer essential urban spaces for pedestrian use, function as the fastest automobile link.

It is important first to spot holes in spatial continuity, then to fill them with a framework of buildings, connective streets, and interlinked open spaces that will generate new investment. Designers should identify the gaps and possibilities before engaging in any site-specific architecture or landscape scheme. Residual spaces between neighbourhoods and the wasteland at their edges deserve special attention. We need to reclaim these lost spaces by turning them into opportunities. Infill and recycling can incorporate such residual areas into the city fabric. While the potential varies by cities, multiple research has indicated that infilling on underdeveloped land and transforming existing neighbourhoods can accommodate 50 to 100% of the projected metropolitan growth.

Studies in Melbourne, for instance, have shown that the city's population can be doubled on just 7.5% of the urban area. This would require strategic densification along the existing tram and bus networks. Infill schemes would redesign underutilized sites with a combination of three- to four-story development and seven-story blocks[18].

DESIGN SMART AND GREEN DENSIFICATION



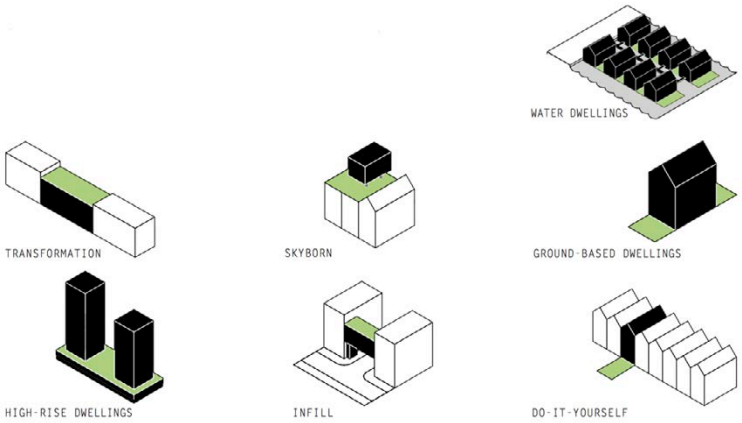
An interwoven strategy. Overview of the potential for densification, diversification, and green intensification in Rotterdam by 2040. Source: Tillie et al. 2012.

[17] Trancik 1986.

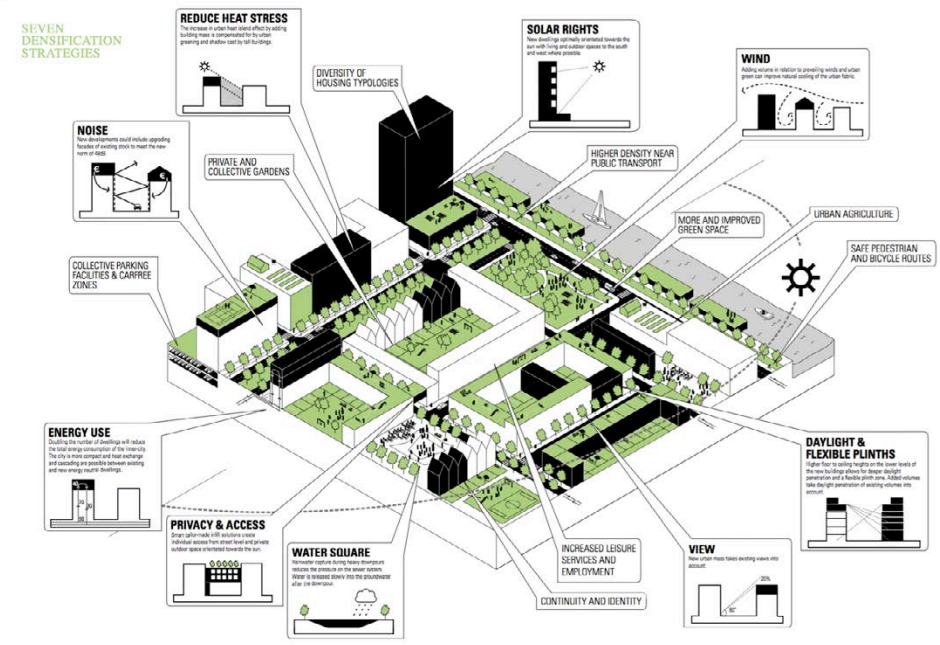
[18] Adams 2011.

Densification is a step-by-step process. It is not about introducing as many dwellings and offices in the community as possible. The challenge is to increase the number of attractive houses and amenities in such a manner that the quality, liveability and microclimate of the neighbourhood ameliorate. Densification should go hand in hand with the upgrading and expansion of the outdoor green. Adding edifices and green spaces in the right place and at the appropriate scale can improve the mix of functions, cool the urban fabric, and strengthen or repair the character of a city block or neighbourhood.

Urban designers need to address with tailor-made solutions private and collective outdoor space, direct access to and visual and acoustic contact with the street, and control over concealment levels ranging from public to private. Densification in an existing urban fabric is a matter of accuracy. Besides creating the correct mix of dwellings and amenities to restore the identity and aspect of a living environment, smart and bioclimatic design can enhance the comfort in both buildings and the public realm. Designers should preserve daylight, solar rights and views from dwellings. Small, precise interventions can capitalize on residual space without degrading the quality for inhabitants.



Seven Densification Strategies. Source: Tillie and al. 2012. Drawing by Doepel Strijkers 2012.



Smart and bioclimatic densification. Source: Tillie and al. 2012. Drawing by Doepel Strijkers 2012.


Left: Floating homes in Rotterdam. Right: The Wikkelboat in Rotterdam's Red Apple Marina, a prototype of the Floating Community. The harbour lofts in the Nassau Harbour, on the left picture, feature solar panels and have their own water purification system, as well as generating heat using a biomass installation. The developer will also be facilitating the introduction of shared bicycles and shared electric cars which the buyers of the floating homes and other residents of the neighbourhood will be able to use. The municipality has also laid out a nature-friendly bank, ensuring an enhanced variety of animals and plants, thus making the living environment even greener.

The seven green densification strategies proposed for Rotterdam shown in the drawings above are[19]

1. Ground-based dwellings. Access at ground level makes a street featuring ground-based housing particularly attractive, not only because it contributes to distinguishing the individual dwelling, but also as it increases the liveability of a neighbourhood. Undeveloped plots of land and large outdoor public spaces lend themselves to this form of densification. Traditional typologies such as terraced houses, patio houses, and urban villas form the 'repertoire' of this strategy.

2. Water dwellings. Unhindered by cadastral plots of land and existing building lines, a multitude of different water dwelling types are possible: quay blocks at the interface of the city and water, jetty-, pole- and floating dwellings make optimal use of this dynamic environment.

3. High-rise dwellings. Attractive collective space, amenities and significant outdoor space per dwelling compensate for the fact that there is no ground-based garden or front door. Rather than being just vertically stacked dwellings, qualitative high-rise housing can be characterized as vertically stacked living environments with sky terraces and sky gardens.

4. Transformation. As housing is less sensitive than offices to economic conditions, a mix of dwellings with offices could provide a more stable backbone for an attractive inner city. Situated, from an economic point of view, in the most attractive locations in town, inner city office buildings provide optimal opportunities for high-quality living. The scale and construction typologies of office buildings are suitable for creating attractive houses with voids and large, flexible houses with built-in collective space.

5. Sky-born. A sky-born densification strategy optimally exploits the proximity of urban amenities and green infrastructure. Because new dwellings need to adapt to existing substructures, this strategy encompasses a large diversity of building typologies: from roof villages with a communal character, to individual penthouses, to building- block-on-block constructions. Collective green outdoor space can be created at roof level, with additional private outdoor areas in the form of large balconies or patios.

6. Infill. The urban fabric of terraced houses, corner houses and flats can be completed by dwellings that fit in with surgical precision – infill housing. Gaps above narrow delivery streets, undeveloped plots of land and large courtyards can be filled in with dwellings that cross the street like a bridge, hover above a parking lot or complete a block of buildings. In so doing, the

[19] This description draws on *Tillie and al.* 2012.

identity of the urban fabric can be strengthened, increasing the diversity and attractiveness of a neighbourhood. With their proximity to urban amenities such as shops, parks and public facilities, infill dwellings fully exploit the advantages of urban living.

7. Do-it-yourself. With their characteristic facades, nineteenth-century housing stock appeals to a large group of home buyers. In this case, it is not about densification in terms of square metres, but rather about the adaptation of building blocks. Because these dwellings were originally ground-based homes, they are always in the vicinity of facilities such as schools and playgrounds, which makes them extremely suitable for young families.

Adding building density in the right place can have a positive effect on the microclimate of a block or street. Normally, more mass means more thermal gains, which can increase heat stress. Light and reflective facades can, however, counter this effect, and the intelligent placement of edifices' mass can create welcome shade, lowering cooling demands. Besides, the smart positioning of building volume in relation to prevailing winds, urban green and water bodies can ventilate the city. It makes it more comfortable in increasingly hot summers and heat waves[20].

PLAN FOR FLEXIBLE DENSITY WITH A LONG-TERM ADAPTIVE VIEW

It is important to incorporate flexibility when planning for density. Urban form and density aspirations are not always possible immediately and need to be established up over time. Thoughtful positioning will allow initial schemes to set the context for the future and provide the framework for intensification as the community develops. This requires locating and aligning edifices along streets with no setbacks, creating a positive relationship between public and private domains. Although the number of buildings that can generate a perimeter block may not be instantly sufficient, this approach, if considered beforehand, can enable increasing the density in the future.

Density should not be fixed forever. The city 'is the product of many builders who are constantly modifying the structure for reasons of their own. While it may be stable in general outlines for some time, it is ever changing in detail. Only partial control can be exercised over its growth and form.'[21]

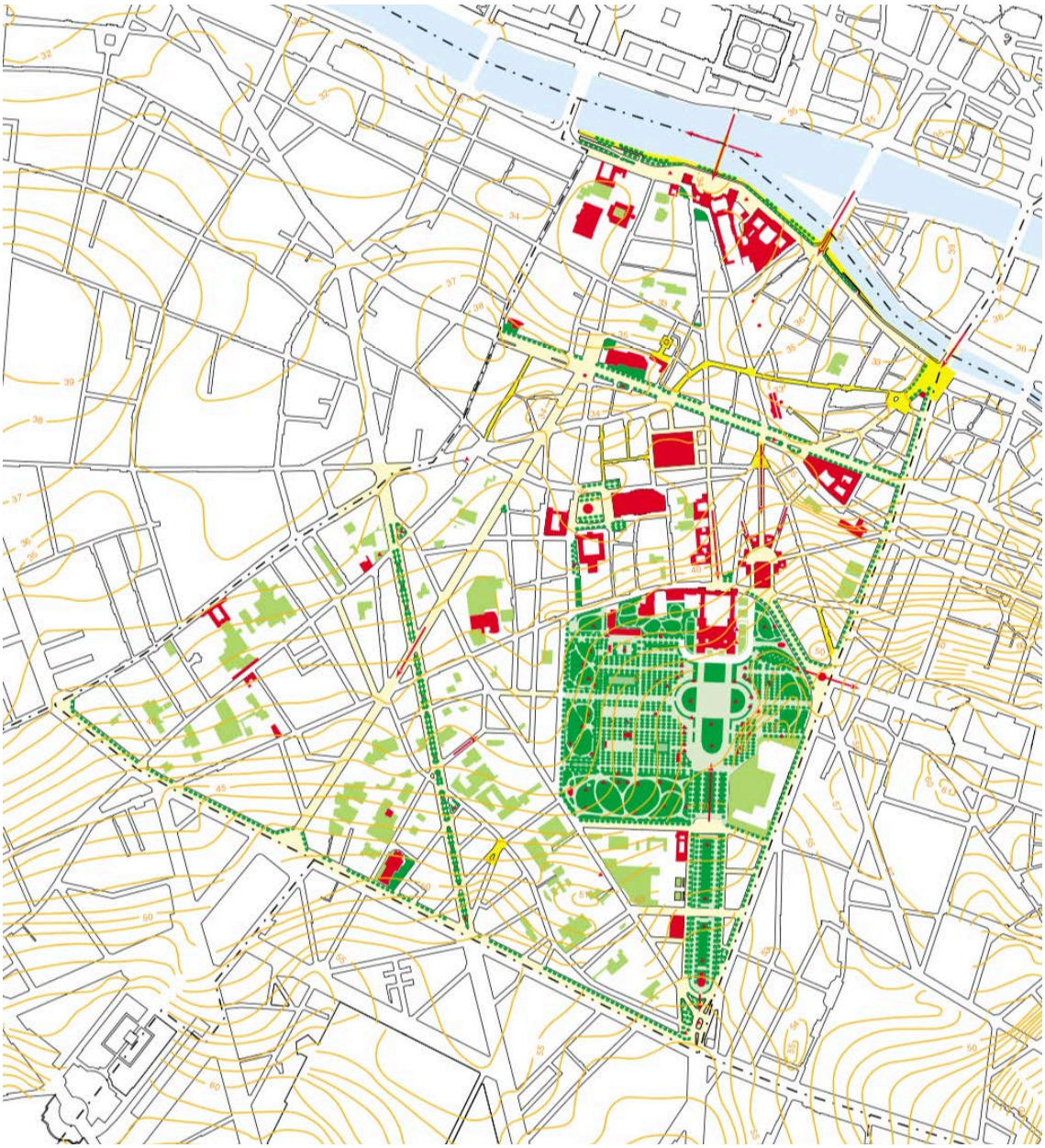
The different concentrations (physical, economic, social) change as areas adjust and mature. This capacity for transformation and intensification should be integrated into both the master plan and, as much as possible, the design and production of buildings. Potential approaches include the concept of homes for life. Design and construction enable their easy adaptation to reflect the inhabitants evolving needs. Houses may allow conversion or enlargement by employing an attic, reconfiguring spaces to create rooms of different sizes, or expanding at the back, side or up. Those resilient dwellings will respond better to changing social and demographic trends and thus be more sustainable in their usage. Including flexible homes that can be subdivided will help to increase density incrementally.

[20] Tillie et al. 2012.

[21] Lynch 1960.

CASE STUDY: SUSTAINABLE MIXED USED DENSITY BENCHMARKS, THE EXAMPLE PARIS' SIXTH ARRONDISSEMENT

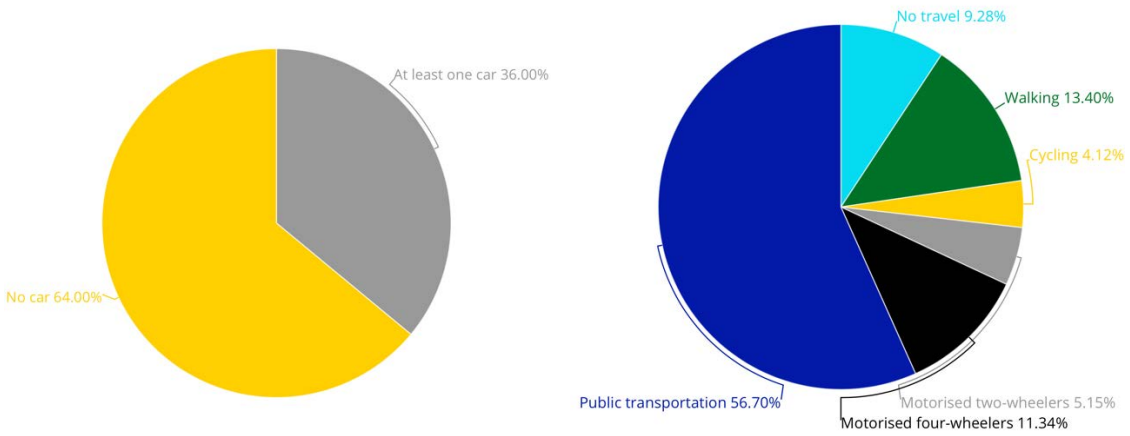
The most striking urban landscapes of the sixth arrondissement result from the meeting between the Haussmannian boulevards and the medieval streets, where the regular built fronts stand facing the older buildings. Institutions are embedded in fragments of ordinary architecture. The superposition of the two street patterns, Haussmannian and earlier, offers contrasting discoveries, at the scale of the pedestrian and the cyclist.



Paris sixth arrondissement urban structure (in red: monuments, in green: green spaces). Source: APUR 2011.

Some isolated and strongly staged monuments emerge. The Observatory, at the end of the alleys, with the Luxembourg Gardens, constitutes one of the most didactic landscape compositions in all Paris. It mixes all eras with the revelation of the Paris meridian.

Detailed analysis of Paris 6th arrondissement gives disaggregated benchmarks of sustainable green density and its components. The population density of this 2.15 km^2 district is 19,500 people/km^2 which results in a vibrant district life while preserving green spaces. At the scale of Paris, the 6th arrondissement has a particularly pronounced mix of housing and employment. The district offers 1.1 jobs per resident[22], which is quite balanced and allows three quarter of its inhabitants to work in the same area where they live. This job/housing balance within a relatively small district has a strong impact on the modal share for commuting to work. Two thirds of households don't own a car and only 11% commute to work by car. The district is highly walkable in terms of street patterns and benefits from an extensive and dense network of public transportation. As a result, almost 20% of residents walk or cycle to their job and 56% use public transportation. The district comprises a subway station on average less than 225 m from homes (13 subway stations) and 22 bus lines (10 per square kilometre). Several cycling routes traverse the district.



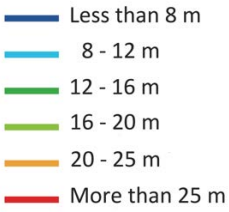
Car ownership and modal share in Paris 6th district. Source: Urban Morphology and Complex Systems Institute.

[22] The highest concentrations of employment are in the north and west of the arrondissement where density exceed 250 jobs/ha, or even locally 500 jobs/ha.

Seven-story high buildings along the main boulevards delineate a compact urban fabric. The Floor Area Ratio (FAR) exceeds generally 4 and thus appears among the high built density of Paris, at least for the left bank. The built form is fine grain with between 25 and 40 buildings per ha.

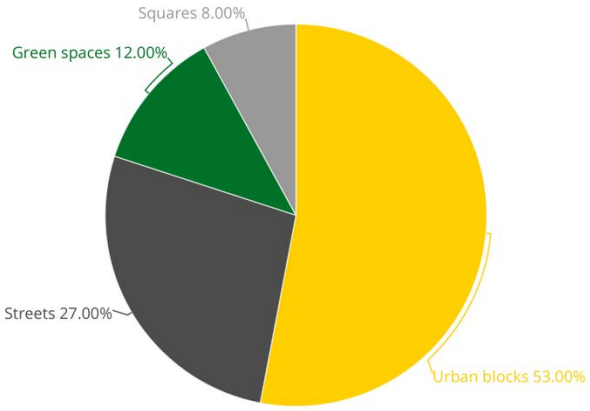
The streets occupy 27% of the land area, corresponding to UN Habitat recommendations for sustainable neighbourhoods. The street linear density also corresponds to UN Habitat recommendations. It is 20 km of streets/km^2. The streets are organized into a hierarchy of types and widths comprising connective long straight boulevards and a variety of shorter intermediate streets. The total street length is distributed with a few boulevards more than 25 m wide and many narrower streets less than 12 m wide, most of them dating centuries ago. Boulevards represent less than 30% of the street length. This complex street pattern comprises a variety of street widths. This results in an average street width of 13.7 m from façade to façade, which is also a good benchmark for a sustainable and balanced street pattern. The street network is densely connected with 190 crossings per square kilometre, above UN Habitat recommendations for sustainability and similar to the density of intersections encountered in the most liveable European cities described earlier in this chapter[23]. Average distance between intersections is 75 m typical of walkable neighbourhoods.

[23] Salat et al. 2011.



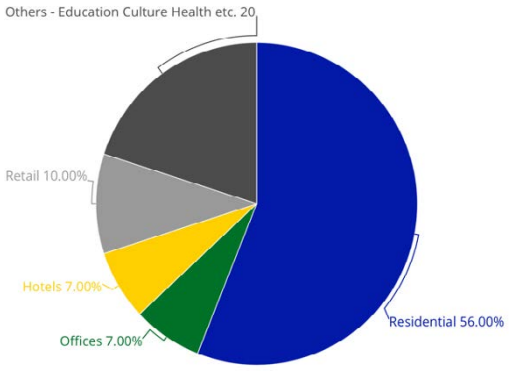
Framing the Luxembourg Gardens, the main street structure of the 6th arrondissement forms a quadrilateral. The latter is superimposed on a network of older streets. These converge on the Seine and distribute the centre of the arrondissement. Street width (from façade to façade) distribution in Paris 6th district. Source: APUR 2017.

The land distribution confirms that in a sustainable district about half of the land should be public open space (47% in Paris 6th district).



Land distribution in Paris 6th district: Source Urban Morphology and Complex Systems Institute.

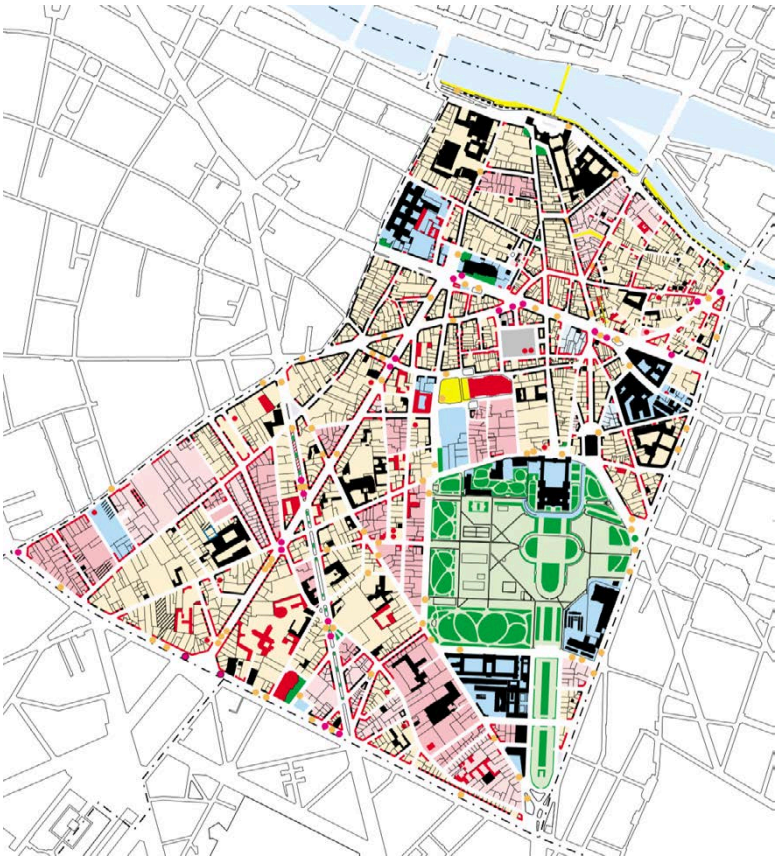
The public realm (squares and green spaces) completing the streets occupies 20% of the land area. The 6th has 252,250 m^2 of green spaces, divided into twelve gardens and squares, the Luxembourg Garden alone comprising 224,000 m^2, or nearly 90% of the total green area. The district comprises 12% green spaces[24].



Gross Floor area per use. Source: Urban Morphology and Complex Systems Institute.

[24] However, the provision of public green space per inhabitant (6.35 m^2) does not match that encountered in other European greener cities. Those cities offer 36 m^2 green spaces per capita in Amsterdam, 45 m^2 in London, 59 m^2 in Brussels, 321 m^2 in Rome.

The density is highly mixed use with about 80 m^2 GFA[25]/capita among which one half is residential and the other half for offices, retail, hotels, education, culture, healthcare. The 6th arrondissement has around 3,140 shops. This commercial fabric is particularly rich and diversified. The 'cultural' district par excellence, the 6th brings together shops related to antiques and art, publishing houses and bookstores. The food trade is well established: the arrondissement has 4.2 food shops per 1000 inhabitants, which represents a high rate (Paris: 3.3 per 1000). Many streets provide a continuous shopping experience. The density of commercial premises also offers a good benchmark for the density of retail (per ha, per m of street, per inhabitant) to be targeted in a vibrant mixed-use neighbourhood. On average the district comprises 14 commercial premises per ha and 7.4 shops every 100 m of street. The district offers 72 shops or commercial services per 1000 residents.



Activity distribution in Paris 6th district. Source: APUR 2011.

[25] Gross Floor Area.

PLAN WITH TRANSIT-ORIENTED DEVELOPMENT

To implement strategic densification[26], Transit-Oriented Development (TOD)[27] is a strong policy framework associated with long-term structural impacts and elevated levels of real-estate value creation. Transit-Oriented Development aligns intensity of land use (by encouraging higher economic, job, and people density) in the places that are the most accessible by public transport, in station catchment areas or along corridors. This section describes the land use component of transit – Oriented Development while another chapter in these guidelines (Plan for seamless mobility) describes the transportation system component.

Transit-Oriented Development policies comprise

- Encouraging growth around
  - the significant public transport interchanges
  - the most accessible stations
  - the major network articulations
- Moderating construction in the areas that are less accessible
- Discouraging development in areas that are more than 1 km from a subway station[28].

TOD relates to the compact city model, which aims to improve accessibility based on proximity. This approach relies on spatial planning and investment strategies that also involve mixed use, social mix and sustainable urban design at community scale.

TOD fosters higher-quality and well-connected neighbourhoods, with diminished infrastructure costs, and lower CO_2 emissions. Residents face reduced transport and dwelling expenses. They can access most jobs and services easily with a combination of public transport, walking, and cycling. City leaders can finance improvements to public space, linkages, and social housing by capturing value created through the benefits of integrated land use and transport planning.

Multimodal connectivity and people-oriented design create high value in London's Kings Cross. Photo: © Françoise Labbé.

TOD communities are compact, so they need less land and enable multiple modes of travel, including walking, bicycles, and public transport. Different building types provide options for residents and businesses, encouraging diversity. Neighbourhood layout reinforces accessibility around public transport stations. It establishes dense and connected street patterns. Streets are places for people. The public

[26] In at least four African cities, 43 Asian cities and 54 Latin American cities, Transit-Oriented Development has emerged as an organizing principle for urban growth and spatial planning (Colenbrander et al. 2017; Lwasa 2017; BRT Data 2018). This trend is important to counter the rising demand for private cars in developing country cities (OECD 2016). In India TOD has been combined with localized solar PV installations and new ways of financing rail expansion (Sharma 2018).

[27] For an in-depth description on how to transform urban space with Transit-Oriented Development, see: Salat, Serge; Ollivier, Gerald. 2017. *Transforming the Urban Space through Transit-Oriented Development: The 3V Approach. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/26405 License: CC BY 3.0 IGO.*

[28] Salat and Ollivier 2017.

realm supports economy, culture, and creativity. TOD creates market value and liveability, while preserving heritage and local identity.

The mix of uses, journey options, and varied population makes communities healthy and sustainable. Locating amenities, employment, shops, and housing around mobility hubs promotes the use of both active travel and public transport. Well-planned TOD is inclusive: it ensures access to jobs for all social groups. Moreover, proximity boosts productivity through agglomeration economies. TOD can stop community decline, stimulate growth and leverage private investment in the public interest. It has significant carbon reduction impacts for emissions associated to sprawl, to energy embodied in infrastructure, and for transportation[29].

What makes Transit-Oriented Development successful[30]?

Many aspects span from the characteristics of the mobility system itself to the quality of density, land use, and urban design.

- **Public transport system**
  To make Transit-Oriented Development successful, the following actions are recommended for the transportation system.
    - Increase accessibility to public transportation (proportion of people at walking distance from the transport system).
    - Enhance safety and security.
    - Ensure cost of public transportation is attractive[31].
    - Decrease travel time.
    - Increase frequency.
    - Provide real-time information on arrivals and departures.
    - Enhance connectivity at destinations by public realm improvements integrating seamlessly the stations to the street patterns.
    - Provide seamless integration between modes with for example bus stops close to subway stations or bike-sharing services.

- **Integration of density, land use, and urban design with transportation planning**
  To make Transit-Oriented Development successful, the following actions are recommended for integrating transportation, planning and urban design.
    - Increase people density within 800-meter radius of subway or BRT (Bus Rapid Transit) stations,
    - Increase job density within 400-meter radius of subway or BRT stations.
    - Provide access at walking distance from stations to amenities and services provided by mixed use.
    - Enhance the quality of the public realm with parks, and a pedestrian-friendly network of fine grain connected streets increasing walkability and accessibility

[29] Access to structured public transportation encourages different mobility patterns and has a direct impact on the number of kilometres travelled, and on the use of fuel (both by private cars and public transport) and, therefore, on greenhouse emissions.
[30] Adapted from Fraker 2013.
[31] If the cost of public transport is lower than the cost of parking, gas, and tolls and the time is predictable and equivalent to car travel (even slightly longer), ridership and value of the catchment area neighbourhood will increase (assuming convenient access and frequency of service).

LESSONS LEARNED FROM CASE STUDIES[32]

The tram is the backbone of district connectivity in Hammarby Sjöstad. Photo: ©Françoise Labbé.

- Density intensifies street life while offering up to 40% -50% open green space.
- People and jobs in close proximity to public transport stops support effective mobility systems.
- In Hammarby Sjöstad, Kronsberg and Vauban, a transit spine structures compact linear configurations.
- Minimum density within catchment areas makes public transport cost-efficient and affordable.
- Frequencies are no more than six to eight minutes apart. Stops are less than 300 metres from homes. They offer climate shelter and real-time information on schedules. Different travel modes are seamlessly connected.
- Parking ratios are limited to 0.2-0.8 space per unit.
- Street design includes traffic calming measures.
- Street networks provide continuous pedestrian and bike dedicated lanes, with bike parking and with regular shortcuts through blocks and urban parks.

PRIORITIZE WITH THE 3-VALUE FRAMEWORK [33]

A methodology introduced by the World Bank, called the '3-Value Framework[34]' outlines a typology of locations to facilitate TOD implementation in various contexts. **This publication by Serge Salat and Gerald Ollivier, *Transforming the Urban Space through Transit-Oriented Development: The 3V Approach*, is accessible at the World Bank following link:**

https://openknowledge.worldbank.org/handle/10986/26405

The 3V framework aims at

- communicating a vision that articulates intensity of land construction and accessibility
- identifying the growth potential of different areas around public transport stations: type, scale, timing, market demand

[32] Adapted from Fraker 2013.
[33] This section is based on Salat and Ollivier 2017.
[34] Salat and Ollivier 2017. The 3-Value Framework has been adopted in India with a national guideline issued by the Ministry of Housing and Urban Affairs, Government of India, *LAP (Local Area Plan) for transit. Illustrated handbook for Indian cities,* 2020.

- prioritizing limited public resources to create and capture value
- developing planning and execution measures.

The 3-Value Framework is a tool for prioritizing investment and implementing Value Capture Finance. It is based on the decomposition of the value of a location into three key dimensions:

- **Node value**, which assesses the accessibility and centrality of a place within a transportation network.
- **Place value,** which assesses the urban quality of a place both through its concentration of amenities and its urban design, in particular the quality of the public realm.
- **Market potential value**, which assesses the attractiveness of a place for development through the vibrancy of its land and real estate markets. Although dependent of the two previous values, market potential is also driven by specific features of the place such as for example the land available for redevelopment.

These three values allow with a set of metrics to entangle the complex dynamics that drive the development potential of a place: accessibility, connectivity, liveability, market readiness. Investment in transport infrastructure is not enough to secure local development. Urban vibrancy and market readiness also matter.

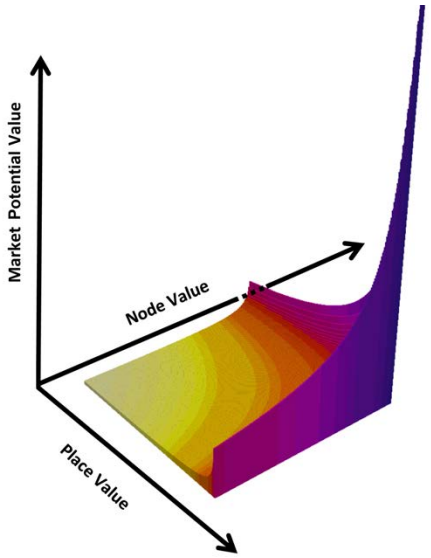
Public sector first stimulates demand from the private sector by increasing connectivity and/or FARs. This unlocks the potential value of underused assets (land and/or structures). Subsequent investment and development from the private sector should then ensure the realization of the potential asset value increase. Comprehensive master planning and integrated design enhance the public realm and create streets as places for people. These improvements and the intensification of jobs, businesses, health and education near homes realize value. Schemes such as King's Cross, London, Hudson Yards, New York, Hammarby Sjöstad and Bo01 Malmö, Sweden, Marina Bay, Singapore, or 22@Barcelona, Catalunya demonstrate the success of such approaches.

Residents are valuing the liveability and connectivity of a place. Value reflects their preferences in terms of urban form, schools, access to daily amenities, walkability. It is enhanced by connections with jobs or other amenities used less than daily in the rest of the city. Companies are looking for optimizing profitability and productivity. In the service industries, they will typically converge to locations with a high job agglomeration. Such value creation strengthens local quality of life, while providing for enhanced job opportunities through good connections at city level using mass transit. This analysis suggests a three-pronged approach to maximize value in an urban location.

1. **Increasing connectivity, accessibility, and centrality**
   Centrality captures accessibility of an urban location within mass transit networks.

2. **Enhancing urban planning quality**
   Urban quality describes vibrant neighbourhoods with dense and connected street patterns, mixed use, proximity to amenities such as schools, and to transit stops, good jobs/residents balance.

3. **Strengthening market demand**
   Forces of agglomeration motivate people and firms to locate where they can access a high number of people and other firms. People and job density and its forecasted growth drive market potential.



Synchronization of node value peaks (major connecting hubs) with high-quality place making fosters spikes of market potential value.

The 3-Value Framework is both a description of the interplay between connectivity, urban quality and market readiness that drives a neighbourhood development and a tool that measures these drivers of value creation with a series of metrics. Integrated neighbourhood planning can influence and improve the performance of a neighbourhood along all of these metrics.

NODE VALUE

Node value is a key property of a neighbourhood. It measures its integration in the city overall transportation network and it may be enhanced by integrated land use and transportation planning. In technical terms, node value uses network theory to measure the centrality and accessibility of a location within the public transit network. The available transportation modes and the quality of their linkages influence it.

Intermodal diversity refers to the number and variety of transportation modes a station connects. The more options and choices a station offers, including interconnections to subways, buses, and high-speed rail, the higher its connectivity.

Hubs along Crossrail in London. Source: TfL.

Integrated neighbourhoods should offer a variety of transport modes and the land use and transportation integrated planning should aim at enhancing this variety at close distance by linking them into an easy to navigate the public realm. For example, by interconnecting different transportation modes in a neighbourhood, planning can create a hub with a strong potential for development. An example is King's Cross in London where the potential for development and regeneration benefitted from the convergence of 6

subway lines and 17 bus routes. King's Cross is an extreme case of node value created by integrated planning. Strategies for local development in Japanese cities such as Tokyo are also based on creating strong interchange stations. More generally, hubs are special. They dominate the structure of all networks in which they are present. With links to an unusually large number of nodes, hubs create short paths between any two nodes in the system. They are referred as 'degree-central' stations[35]. Some stations are closer to all the other ones in the network, this is termed 'closeness centrality'[36]. Some nodes are also strong because many routes through the network pass through them. This is named 'betweenness centrality'[37] and captures the fact that these nodes articulate different parts of the network. In Tokyo, for instance, these between central stations have become the seeds of highly intense integrated urban development along the Yamanote line. Other nodes are special because they are linked to other very connected nodes, in network theory this is called 'eigenvector centrality'[38].

For more information on the definition of these values, how to calculate them and how to use them to articulate the levels of density across the urban space, see: Serge Salat and Gerald Ollivier, Transforming the Urban Space through Transit-Oriented Development: The 3V Approach, is accessible at the World Bank following link:

https://openknowledge.worldbank.org/handle/10986/26405

PLACE VALUE

Place value describes the urban characteristics of a place and its attractiveness in terms of urban fabric, amenities, schools, and healthcare. It is typically increased by applying the recommendation of these integrated design guidelines. Residents value vibrant communities where they can access jobs, shopping and services on foot or bicycle. Inhabitants of such neighbourhoods enjoy a range of benefits such as reduced transportation costs, improved access to amenities and education. Urban quality is uneven across cities. In a typical city, many areas are mainly residential with low diversity, no jobs and businesses,

[35] Degree centrality is the number of links per node. London's subway, for instance, is dominated by King's Cross as the most connected London node with 6 subway lines. The highest degree centralities are around the Circle Line and along the Central Line, that define Central London. Centrality peaks in the western part of Central London where one third of London's jobs are concentrated in a small area. Shinjuku station in Tokyo is an interchange between 12 lines. An average of 3.6 million people per day use the station, making it, by far, the world's busiest transport hub.

[36] Closeness centrality expresses the distance, measured in number of links, from a station to every station in the network. Closeness centrality tends to assign high scores to stations near the centre of local clusters. Closeness centrality analysis in London's subway network confirms that Central London is the part of the network accessed from everywhere through the shortest paths.

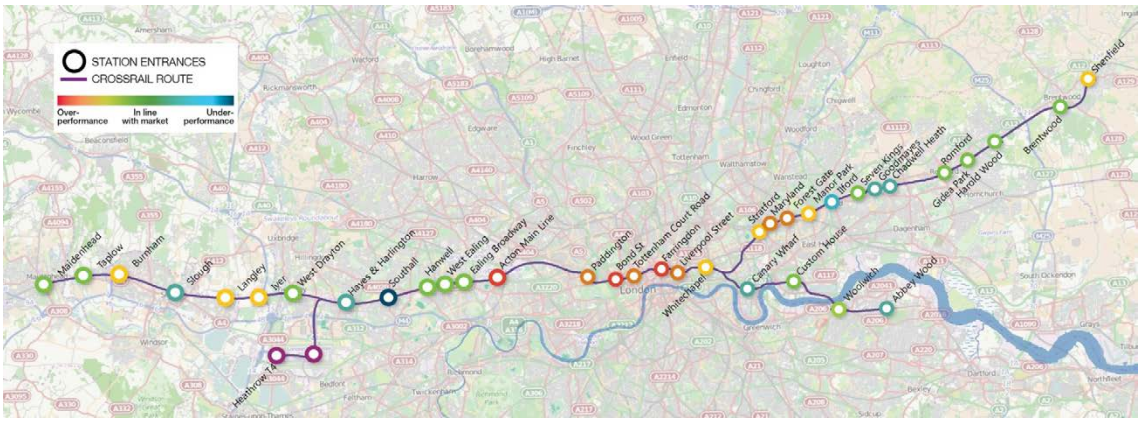
[37] Betweenness centrality is equal to the number of shortest paths from all stations to all others that traverse a given station[37]. A station with high betweenness centrality has a large influence on the transfer of passengers through the network. Many of them must transfer there between distinct sub networks, such as suburban trains and subways. Examples are the interchange stations along the Circle Line in London and the Yamanote Line in Tokyo, which have maximum levels of betweenness centrality.

[38] Eigenvector centrality allows identifying stations according to their linkage to other well-connected stations. It captures the intuitive notion that nodes are more central when they are interconnected to other central nodes. In subway networks, eigenvector centrality of a station gives the surrounding area a premium advantage as it is linked to other well-connected places. For their locational choices, people and firms will favour these areas to minimize transfer times. In Tokyo, stations along the Yamanote line rank amid the first 10 highest values for eigenvector centrality in a network that comprises 2,000 stations and their neighbourhoods are among the most thriving.

while a few locations are more job oriented, mix use, and with a vibrant urban life. Walkability is also different and depends on the street network and on the design of streets. Street patterns determine how easily residents can reach rail and bus stops, and the shopping, jobs, and services in their immediate neighbourhood. Street patterns with small blocks about 100-meter side and high connectivity enhance local accessibility. Whatever the initial conditions of a neighbourhood, integrated planning and design can significantly improve its liveability, place value and attractiveness. Increases in place value are fostered by the public realm strategy described in these guidelines, nature-based solutions and well-designed green spaces, and the design of walkable streets as places for people. Increasing place value with integrated neighbourhood planning comprises the following actions.

- Increase the percentage of residents at close proximity (200 m for buses and 400 m for subways or BRTs) to public transit stops.
- Increase the diversity of uses.
- Create job opportunities in the neighbourhood and increase the job/resident ratio.
- Add connective streets when missing and target a high street linear density (street length/km^2).
- Connect street networks made of cul-de-sacs to reach a high intersection density (number of street intersections/km^2).
- Reduce the average distance between intersections and increase the permeability of the urban fabric for example with shortcuts within blocks.
- Increase the proximity to elementary schools and to middle schools by adding schools in the neighbourhood.
- Enhance healthcare facilities in the neighbourhood.

MARKET POTENTIAL VALUE



Property price performance along the Crossrail route in London. Source: JLL Residential Research 2015.

Market potential relies on the demand and attractiveness of the place for developers and businesses. Integrated planning enhancing the local economy vibrancy with actions described in a specific chapter of these guidelines can increase the market potential value of a neighbourhood and initiate a positive feedback loop of value creation and capture (see also the specific section in the finance chapters).

For enterprises, local job density and good connections to other job concentrations across the urban area are crucial as they determine the agglomeration economies offered by a neighbourhood. For residential development, market potential depends greatly on the number of jobs accessible in 30 to 45 minutes from a location, as residents want to reduce their commuting time, or at least maintain it at a reasonable level. Market potential results from the dynamics of demand and supply.

- **Demand**
  - Current and future human density (residential plus employment) determine the economic opportunities for local businesses.
  - Current and future number of jobs accessible by transit within 30 minutes determine agglomeration economies that drive enterprises locational choices.

- **Supply**
  - Developable land can be an opportunity or a constraint for developers.
  - Changes in zoning (such as increasing floor area ratios – FARs) offer new opportunities for development by infill.
  - Market vibrancy (increase in transactions) reflects the attractiveness of the neighbourhood compared to other locations in the city.

NEIGHBOURHOOD TYPES

The three values are uneven across neighbourhoods. Some places comprise important interchanges between various subway lines and different transport modes. They offer high prospects for new developments. Other neighbourhoods afford less growth potential, because they are in suburban areas, with less vibrant real estate markets and fewer connections to the rest of the public transport network. However, they offer other opportunities, such as cheap available land to redevelop. Different locations require thus distinct strategies, investments, and policy instruments and integrated neighbourhood planning should consider different challenges and potential linked to neighbourhood locations and existing urban quality.

Classifying Locations Based on Node Value

Node value is higher at subway network cores than at the periphery. At network cores, stations are interlinked in dense clusters around major hubs. At the network periphery, the distance between stations increases. This allows a classification of locations into single-line station areas, transfer station areas, and highly connective hubs.

- ***Single-line station areas*** belong mostly to the branches of the urban rail system extending outward into the suburbs.

- ***Transfer station areas*** interconnect two or more lines.

- ***Highly connective central areas*** rank high in intermodal diversity, centrality, and intensity of passengers flows. They have the maximum node values.

Classifying Locations Based on Place Value

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

- ***Suburban areas*** lack public transportation or the urban character that would best support TOD. They are low to moderately inhabited areas that necessitate a combination of street connectivity, pedestrian and bicycle facilities, and urban amenities to support an increased level of transit service. Suburban areas are generally mono-functional (either residential or industrial or business parks, with no mixed use) on large tracts of land.

- ***Urban areas*** are populated places with a good or improving pedestrian/bicycle network and some mix of neighbourhood retail and service amenities and a moderate mix of supporting jobs.

- ***Intense urban areas*** combine maximum diversity and intensity of uses with peaks of economic concentrations.

Classifying Locations Based on Market Potential Value

Locations can be grouped into three types based on their market potential value: limited, emerging, and strong.

- ***Limited areas*** have weak market potential and lack the demand necessary to support new compact and/or mixed-use development. TOD investments in these places are less likely to catalyse additional private schemes and should be employed only on a limited basis. An emphasis on visioning and planning, to begin to spur interest, is more appropriate.

- ***Emerging areas*** have limited to moderate real estate market strength. They do not support intensive building types in the near term. Catalytic projects can enhance market response, because land and development costs are not high and small investments may initiate further market interest.

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

STRATEGIES FOR DIFFERENT TYPES OF LOCATIONS: INFILL, INTENSIFICATION, AND TRANSFORMATION

TOD investments stimulate a market response, and are effective when accompanied by other incentives. Integrated strategies include public realm and green spaces enhancements, human capital, neighbourhood services, and business development, which may improve an area's long-term prospects. Many suburban areas have limited near-term market development potential but substantial land opportunities. Three types of implementation strategies can be utilized.

- **Infill** is mainly for nodes in suburban neighbourhoods with single transit lines and low market potential value. It encompasses the reuse of land for new, higher-density construction. Based on long-term scheduling, infill involves incremental increases in density, occupation levels and public transport service. It also comprises planning and funding a multimodal mobility system and actions for maintaining equity in vulnerable communities. Such places can provide good opportunities for affordable housing.

- **Intensification** is for emerging areas in urban neighbourhoods with interchanges and growing markets. These locations are typically built-up areas with good existing or planned public transport links. They can support redevelopment at higher than present density. The strategy is to invest in catalytic projects to prime and push the market, promote development-oriented schemes, and address missing multimodal connections and accessibility issues. Such places can be prime opportunities to provide affordable housing.

- **Transformation** is the strategy to apply in major hubs. Establishing a high level of place value – with job concentration and good urban design, including high levels of investment in public spaces – can foster high peaks of land and real estate value. The roadmap is to invest in aggressive TOD projects to push the market, with significantly higher density 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 actionable strategies depend on the relative strengths of values at each location. A location with a strong node value (a highly connective major hub) such as King's Cross, for instance, acquired a high market value through massive investments in high-quality public space when the market timing was right. Such a strategy is transformative. At the other end of the range, in suburban stations on a single line with a limited market prospect, infill development should be favoured.

KEY STRATEGIES TO INCREASE NODE, PLACE, AND MARKET POTENTIAL VALUES

Value	Policy lever
Node	• Increase the number of hubs and of lines/modes they connect to. • Interlink neighbouring stations into clusters. • Enhance accessibility for all within the network.
Place	• Strengthen compactness (proximity to existing urban activity and short travel time to main destinations). • Diversify uses. • Increase the concentration of commercial, cultural, and educational amenities. • Design neighbourhoods that promote walking and cycling. • Create a vibrant public realm.
Market potential	• Increase residential density. • Increase job density. • Encourage the diversity of land parcels to create a vibrant land market. • Heighten floor area ratios with strategic zoning.

Increasing Node Value

Networks with powerful convergence of routes in focal points, which interconnect many lines and transportation modes, shape economic concentrations in spikes, with peaks of value. In contrast, 'flat' networks don't present major hubs and dense interconnections of lines in a core. They do not offer strong opportunities for capturing high land values around stations. As efficient 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. Examples are London, New York, Tokyo, and Seoul, where subway network has structured growth in polycentric urban patterns with spikes of density.

Key strategies for heightening node value implemented in London and Tokyo include interlinking neighbouring stations into clusters and increasing accessibility of core stations within the network. Interlinking tightly connects the network, offering passengers varied possibilities for interchange.

Increasing Place Value

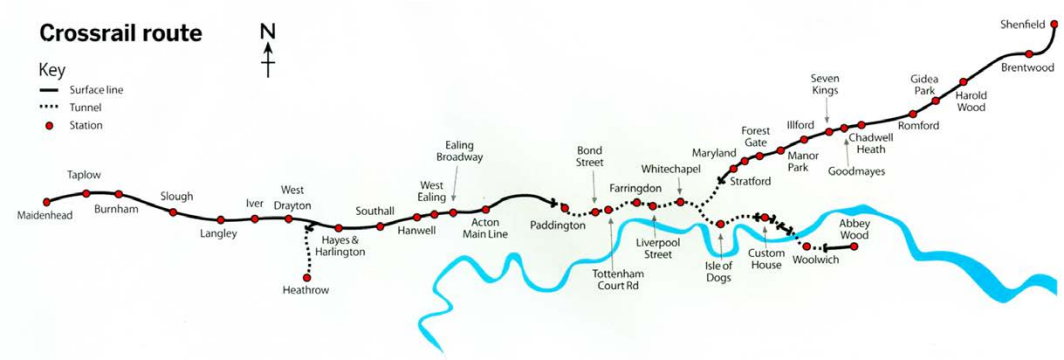
The optimal mix of transport, economy, health, educational, and recreational opportunities ultimately gives rise to people-centred communities. Key strategies for raising place value are increasing compactness and the variety of land uses and enhancing the public realm.

The compact city (or city of short distances) results in integrated neighbourhoods with good walking and cycling connectivity and orientation toward transit stations. A dense resident population offers opportunities for social interaction and a feeling of safety.

Providing diverse and complementary uses within the same or adjacent blocks reduces trip lengths and support the clustering of economic activity. Vibrant and sustainable communities give access to a concentration of commercial, cultural, and educational amenities.

Good urban design is a major strategy to foster place value. It includes significant streetscape improvements that make streets places for people; establish a spirit of place; make the city more legible; and create a feeling of enclosure, human scale, coherence, and linkage.

CASE STUDY: INCREASING PLACE VALUE THROUGH PLACE-MAKING, REDEVELOPMENT, AND THE PUBLIC REALM ALONG CROSSRAIL IN LONDON[39]



The diversity of neighbourhoods along the new 100 km Crossrail line running east west in London required tailored strategies. Crossrail Limited 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 objective is to ensure that these enhancements are integrated with existing and planned improvements in the wider area and reflect other planned uses. Master plans are produced with key stakeholders, including local authorities and private developers.

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

The station area designs also target to retain the identity, diversity, and characteristics of areas, giving confidence to communities and potential investors. Toward that objective, boroughs (local administrative units) play a vital part in raising funds for the projects, to ensure that designs will spread upgrades and regeneration impacts.

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 metres of improved public space at 40 sites. The 'Crossrail effect' is already happening in the centre of London, at locations such as the east end of Oxford Street, while developers are also showing interest in outer London places such as Abbey Wood and Southall.

The financing 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 funding will be split between Crossrail, TfL, and third parties (mainly local authorities through developer contributions).

London property analysts widely recognize that a driving force behind Crossrail's ability to support development activity and property market values is an investment in the extent, configuration, and quality of public space around each station. The new stations, developments above the stations, and planned urban realm transformations have the potential to redefine Crossrail's stations as the centres of the communities they serve. They will be attractive areas 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 place value enhancement in different contexts.

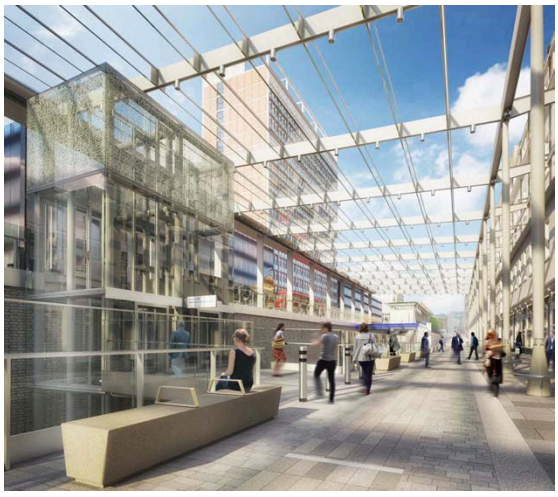
[39] This box draws on Salat and Ollivier 2017.

Maidenhead

Water Pool Focal Point at Maidenhead Station. Source: © Crossrail Ltd.

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. A water pool will act as a focal point that will animate the space and encourage people to linger. Tree planting, high-quality paving materials, sensitive lighting, and seating will provide a positive experience.

Paddington



Urban Realm at Paddington Station. Source: © Crossrail Ltd. Urban Realm Designers: Gillespies/Weston Williamson/URS.

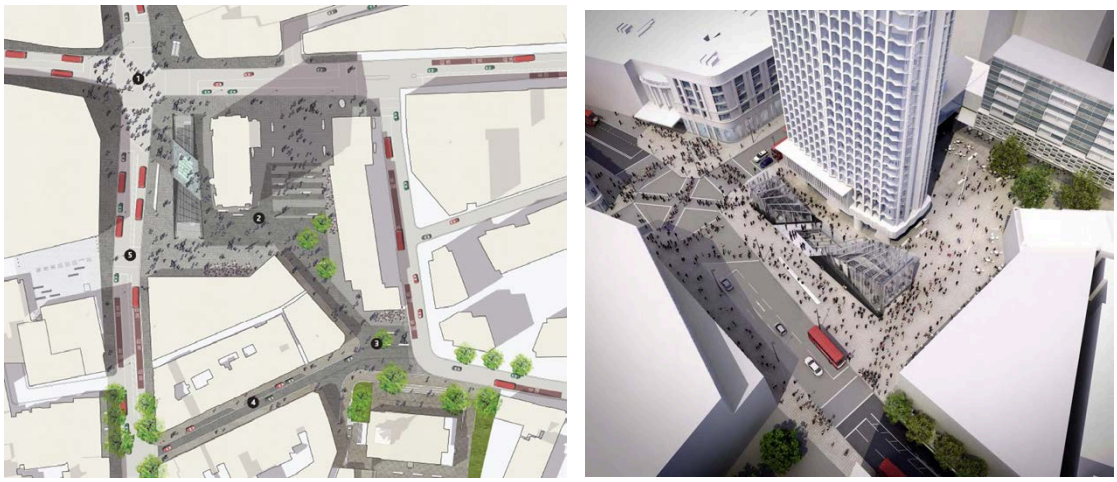
Paddington is a historical Central London railway terminus and Underground station. It is a busy complex served by four underground lines: Bakerloo, Hammersmith & City, District, and Circle. Crossrail will make Paddington a major London hub. An urban realm design scheme aims to complete the waterside public space within the Paddington Basin. Crossrail has also obtained planning consent from the Westminster City Council to build a 32,000-square metre development at Paddington Triangle.

Bond Street

Integration of nearby area at Bond Street station. Source: © Crossrail Ltd. Urban realm designers: John McAslan & Partners. WSP/Publica.

Bond Street is a major historic retail street in London. The new urban realm design for Bond Street West anticipates an increase in pedestrian use. It integrates the new Crossrail station entrance with the surrounding environment. Proposals for Bond Street East offer ample area for pedestrians and create a 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.

Tottenham Court Road



New pedestrian plaza below Centre Point Tower in London's West End. Source: © Crossrail Ltd. Design team: Atkins/Gillespies/AHMM.

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. Crossrail is investing £1 billion to transform the station, making it the biggest transport investment in the West End in decades. Planning approval has been granted for above-site development that will cover four blocks. It features the first new West End theatre in more than a decade and 50,000 square metres of high-quality retail, office, and housing space. Plans include a new public plaza around Centre Point, creating a distinctive new West End landmark. A new open pedestrian space linking Soho 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

Pedestrian walkway at Liverpool Street East. Source: © Crossrail Ltd. Urban realm designers: Urban Movement/Mott MacDonald.

Liverpool Street Station is a key gateway to the City of London (also known as the Square Mile), Europe's leading financial centre. It is a destination for 73 million people a year who utilize the Underground and 63 million who use the national rail. They are on their way to work, or visitors to the City and to the nearby areas of Spitalfields and Shoreditch. The compactness and density of the Square Mile mean that walking is the best way to travel 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.

Whitechapel

Refurbished entrance to Whitechapel Station. Source: © Crossrail Ltd. Urban realm designers: BDP/Hyder.

The refurbished entrance to the station on Whitechapel Road will see a larger forecourt with distinctive paving. Improvements to the area include the pedestrianization of Court Street, with the raising of the carriageway to create a safer walking route.

Abbey Wood

Regeneration of Abbey Wood. Source: © Crossrail Ltd. Urban realm designers: Urban Movement.

The arrival of Crossrail is a catalyst for the regeneration of Abbey Wood. The new station will act as an 'urban bridge'. It will provide 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.

Canary Wharf

Left. Iconic Crossrail station at Canary Wharf. Right. Lattice roof and sky gardens at Canary Wharf Station. Architectural design: Norman Foster. Photos: © Françoise Labbé.

Canary Wharf has the highest density of jobs and office space in London, with about 105,000 jobs on 28.8 ha (an average gross-built density of office space of 7.4). Its history over the past 20 years shows how investment in public transit and in place-making supports economic activity. The Canary Wharf Crossrail Station will cut travel time to the City (Liverpool Street) from 21 minutes to 6 minutes, with a train every five minutes at peak time in each direction. It will trigger high agglomeration economies between the two densest and fastest-growing financial cores of London. Travel time to Paddington will be cut from 33 to 17 minutes; travel time to Heathrow will fall from 55–90 to 39 minutes. The water of the West India Quay dock surrounds the 250-metre-long station being constructed for £500 million. The station and proposed retail and park areas will be seven floors high. Retail zones are planned for three of the seven floors, along with a landscaped garden, restaurant, and community facility on the top floor. The expansion of Canary Wharf eastward allows building up to 3,610 new homes, 1.9 million square metres of office space, 35,000 square metres of retail floor space, a community centre, and a network of public squares. The first stage comprises a public space of 3.6 ha. 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 Value

On the demand side, encouraging higher residential and job density increases market potential. On the supply side, higher FARs and greater diversity of land parcel sizes create a vibrant land market.

Job density establishes agglomeration economies that feed productivity[40]. It increases market potential values as economic density determines firms' locational choices.

Diversifying the size of land parcels creates an adaptive city that meets changes in demand. Manhattan provides a good example of such an approach. Originally, its land plots were sold in units of 200 square metres (about 300,000 units of land for sale). Such

High residential density results in well-populated streets, ensuring that urban locations are lively, active, vibrant, and safe places where people want to live. Density delivers the customer base that supports many services and amenities and makes local commerce thrive. Cities can stimulate heightened density by adjusting their land-use plans.
small plots fostered an active land market with great potential of future mixed use. Over time plots of land in Manhattan have been consolidated, but 40% of all land still remains the initial size established two centuries ago. Few parcels occupy whole urban blocks.

Local authorities can reset FARs at higher values, to allow for densification, to generate revenue streams and to capture them to finance infrastructure (transit and public spaces).

STRATEGIC ZONING

An effective planning instrument for achieving optimal land use is FAR (Floor Area Ratio)[41]. FAR should be set at different levels depending on uses and on accessibility. FARs should also include a margin of flexibility

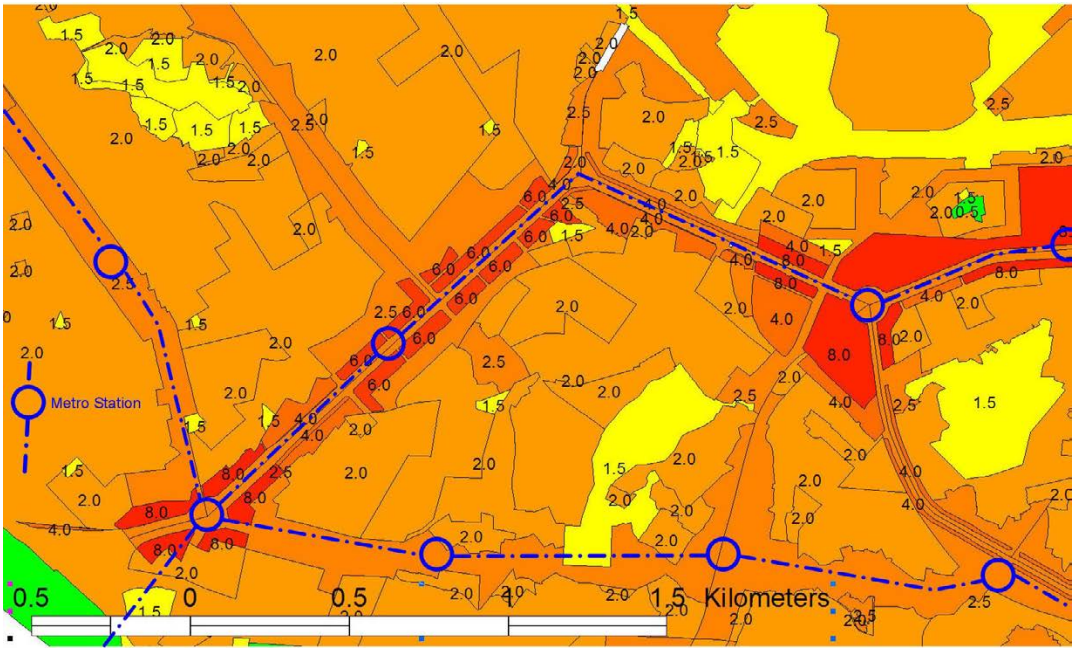
- for transferring FAR between uses according to market changes.
- for allowing the private sector to adjust development intensity to demand.

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 and Seoul also use FARs finely tailored based on proximity to stations.

[40] 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 business cluster, their costs of production may decline significantly. Even when competing 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. Across the United States, job density explains half of the variation in economic productivity per capita. A doubling of employment density in U.S. cities corresponds to a 6% increase in hourly labour productivity (Haughwout 2009). A study of 261 Chinese cities showed that economic productivity in China increases by 8.8% with a doubling of employment density (Fan 2007).

[41] The floor area ratio (FAR) (also floor space ratio – FSR –, floor space index – FSI –, site ratio and plot ratio) is the ratio of a building's total floor area (gross floor area) to the size of the parcel of land upon which it is built.

Zoning policies that increase density according to public transport accessibility have shaped Singapore urban form. The floor area ratio is very high in the CBD (8–25), 6.0 next to the CBD, and 1.5–4.0 in most residential areas. Floor Area Ratios in Downtown Singapore. Source: Alain Bertaud.



Seoul uses zoning to encourage high-density development around public transport nodes and along corridors. 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. The result is a varied and polycentric city in which small residential neighbourhoods are close to thriving business districts. Seoul zoning (neighbourhood scale). Source: Alain Bertaud.

Development must be anticipated to enable density to change as needed. London's King's Cross scheme, for instance, includes margins of flexibility between uses up to 20%. This increases the marketability of a project that will take years before completion. Adapted zoning

in Hudson Yards, New York, sets varied FAR[42] (Floor Area Ratio) for mainly commercial (FAR 10 to 33), mixed use (FAR 6.5 to 12), and predominantly residential (6 to 15). A range between base and maximum FAR introduces flexibility and fosters capture value. Developers may want to build over the base FAR and up to maximum FAR, for instance between base FAR 10 and maximum FAR 33 for commercial use in the densest blocks. They can do so by paying bonus payments into the zoning-based District Improvement Fund (DIF). This initiates an additional real estate opportunity and allows for demand-driven growth. DIF can be used to finance subway lines extensions, public space and inclusionary housing, creating a positive feedback loop of development from the initial rezoning at higher density, and social mix within a grade A mixed-use business district.

[42] The floor area ratio (FAR) (also floor space ratio – FSR –, floor space index – FSI –, site ratio and plot ratio) is the ratio of a building's total floor area (gross floor area) to the size of the parcel of land upon which it is built.

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