

URBAN & INNOVATION ENVIRONMENT INDEX

VOLUME I
2023



Urban & Innovation
Environment
Index

Contents

I	Introduction
II	Methodology
	Results Overview 1:
III	Accessibility of Services & Innovativeness of the City
IIIa	Group 1: Mobility-as-a-Service Indicator 1: Development of Sharing Services Indicator 2: Development of Delivery Services (Goods & Food) Indicator 3: Development of Taxi Services
IIIb	Group 2: Potential for Innovation Indicator 4: Scientific Potential Indicator 5: Cultural Potential Indicator 6: Innovation Support: Development of Government Public Services
	Results Overview 2:
IV	Physical Accessibility & Diversity of the Urban Environment
IVa	Group 1: Balance of Spatial Development Indicator 1: Level of Polycentricity Indicator 2: Functional Diversity of Suburbs
IVb	Group 2: Transport Accessibility Indicator 3: Integration of the Road Network Indicator 4: Public Transport Infrastructure
IVc	Group 3: Diversity of Built Environment Indicator 5: Diversity of Urban Morphology Types Indicator 6: Accessibility of Green Spaces
V	Conclusion
VI	Bibliography

I Introduction

Modern urban planning focuses on improving the «quality of citizen life» and increasing the «comfort of the urban environment». These goals will boost human capital in the city and attract highly skilled professionals. Pragmatically speaking, the proximity and variety of services available are the key indicators of the quality of life and comfort of the environment.

According to the methodological approach of our Index (Urban & Innovation Environment index) a modern city is supposed to help citizens save time with its high-quality and comfortable environment. It is not about our free time and the lack thereof, unfortunately prevalent in the modern world; citizens may choose to redirect the time saved to their own self-fulfillment (Glaeser, 2011), therefore reinvesting it. The diversity of the urban environment offers countless possibilities of such reinvestment. So a high-quality modern city that saves and reinvests the citizen's time can be considered successful (Mouratidis, 2021).

There are two ways to measure a city resident's time savings: active and passive accessibility (Martens, 2012).

Active accessibility means the proximity and variety of functions that a city dweller can reach and access within a certain time. The world's largest cities focus on walkable neighborhoods when discussing urban planning, because it determines the comfort of the environment and satisfaction with the city. A concept of an area where everything a citizen might need is just a short walk away is called the 15-minute city. Active accessibility directly depends on the adequacy of the city's urban planning policy, balance of its spatial development, technological effectiveness and innovativeness of the transportation infrastructure, development of the housing market, diversity and quality of the existing supply.

Passive accessibility measures services that are accessible digitally, online, or at home. It factors in the innovation of the city economy, digitalization, and the development of services rendered by both public and private providers. Passive accessibility is also affected by secondary digitalization, i.e., consistent digital habits and practices, trust in such services.

The study uses the following methodology. Availability of services in general is associated with three important variables: variety, quality, and time costs to obtain the service.

Finding a balance between time spent and satisfaction shapes the environment of a modern global metropolis. Online services co-exist with physical goods in the urban environment. The more time a city dweller saves on “transaction costs”, the more opportunities for self-fulfillment they have and the more attention they pay to the comfort of the environment. The availability of city goods, whether active or passive, measures the comfort of living in the city using the Index, a comprehensive assessment tool.

Such indices and the ensuing rankings of world cities are, in fact, incredibly relevant to the modern urban planning agenda. We identify the following reasons for their popularity (Saez, 2020; Giffinger, Haindlmaier, & Kramar, 2010).

Attracting investments. City indices can be used by city authorities to attract investment. Cities with high scores can be more attractive to businesses and investors, which can promote economic growth and development in all areas of city life.

Comparing and exchanging experience. Most ratings and indices are used first and foremost for comparative research. City indices compare different cities and study the best development and management practices. City authorities can apply this information to improve their cities and share experiences.

Increasing competitiveness. An independent and comprehensive assessment of cities can help local authorities identify their strengths and weaknesses and develop strategies to improve their competitiveness. Cities that rank high in indexes and rankings often attract more tourists, businesses, and talent, which contributes to their development and prosperity.

Consumer awareness and choice. As cities compete for citizens, public visibility and recognition of the city’s place in an index come into play. City indices feature information on various aspects of city life, such as quality of life, economic growth, infrastructure, cultural opportunities, etc. Consumers can use these rankings to make decisions about visiting, living in, or investing in a particular city.

Our Index provides a deep insight into and analyzes the internal differentiation of the urban environment of each city in question. For example, a city may not have consistent quality of life, infrastructure, cultural events available, etc. across different areas. An index that takes into account internal differentiation can highlight these differences and assess each area individually, not to mention provide a more balanced profile of the entire city. It relies on general indicators, average values, and the degree of internal differentiation, flagging any unequally available goods within the city.

Such indices, albeit important, are hard to compile, and there are numerous reasons why.

Data collection and analysis. A fully functioning index requires a large amount of spatially referenced data on various aspects of the urban environment. This can be challenging, especially if the data is not publicly available or collected uniformly across all cities.

Determination of evaluation criteria. Assessment criteria pose perhaps one of the biggest challenges because different experts may have different ideas about what makes a city attractive or of good quality. The cultural context of different countries and regions may also be a deterrent; for example, comfort can be perceived differently depending on the population density, and cultural taboos may affect accessibility to some services.

Cultural differences may also cause difficulties in interpreting data, result in an overall subjectivity, and prevent researchers from completing the index. Even if the data is collected and analyzed correctly, it can be difficult to interpret. What factors should be considered the most important for assessing the quality of life in a city? Some data may be subjective or distorted due to political or economic reasons. This may affect the objectivity of the final index and its reliability.

As we developed the Index, we came across yet another specific challenge: **the lack of cross-country and international rankings** comparing cities, including their intra-city diversity. This is why our team was not able to use any analytical tools available, learn from the mistakes, and build on the previous researchers' experience. Most of the methodological steps we take in this paper are innovations from the academic members of the consortium who are working on this project.

There are several factors behind the novelty of the Index.

We **transition from statistical indicators to indicators of spatial differentiation**. Most rankings of world cities are based on statistical data that is collected differently, affecting the methodology of comparative studies. As we move away from statistical indicators, we seek to both improve the comparability of the analyzed cities and expand on the city-as-a-dot concept that does not factor in internal patterns of differentiation that have a significant impact on a lot of people's lives.

Our Index is looking to address such differentiation and consider the city in all the complexity of its internal structure, giving us the option to analyze inequality as a process that occurs at different scales.

It goes without saying that some passive accessibility is, in fact, available across the entire city, for example, Internet coverage and Internet services that are equally distributed in all city districts. Even in this case, however, there are physical factors affecting the quality of

Internet services, such as road network, public transportation system, proximity of delivery sources. This is what our Index is designed to measure.

The second important innovation is [moving away from the official, administrative boundaries of the city](#). For the world's largest cities, administrative boundaries can be considered a thing of the past that facilitates statistical accounting and division of powers. These boundaries have little to no impact on city residents' lives. This is why this study focuses on a city as a high-density urban area and views boundaries as borders of agglomeration cores.

The third innovation is a [focus on intra-city diversity](#). Depending on different life experiences, lifestyle, family, or economic status, a city dweller needs different city amenities, especially if we consider status changes throughout life or changes in habits. An aspiring global city is supposed to be diverse enough to meet the varied needs of its many residents.

Figure 1 features the results of the first calculation of the Index (Urban & Innovation Environment Index) for the top 30 world cities as well as for the major cities of the BRICS+ countries. The report below describes a brief methodology of the Index and provides calculation data for key indicators. We hope that city administrations, the scientific community, and anyone interested in the topic will benefit from our research. This is a fresh look at the city, taken through the eyes of an ordinary city dweller; perhaps, it might inspire someone to rethink the priorities of urban development.

Figure 1a.
Final Rating of Agglomerations

Rank	Grade	Agglomeration	Total Score
1	A+	Seoul — Incheon	8,22
2	A+	London	7,86
3	A+	Berlin	7,64
4	A+	Paris	7,23
5	A+	Moscow	7,20
6	A+	Shanghai	6,92
7	A	St. Petersburg	6,88
8	A	New York	6,69
9	A	Beijing	6,67
10	A	Tokyo — Yokohama	6,60
11	A	Milan	6,52
12	A-	Guangzhou — Foshan	6,42
13	A-	Los Angeles	6,28
14	B+	Shenzhen	5,66
15	B+	Buenos Aires	5,61
16	B+	Sydney	5,54
17	B+	Mumbai	5,43
18	B+	Sao Paulo	5,29
19	B	Istanbul	4,85
20	B	Delhi	4,82
21	B	Bangkok	4,74
22	B	Riyad	4,74
23	B	Rio de Janeiro	4,68
24	B	Mexico	4,60
25	B-	Manila	4,47
26	B-	Tehran	4,38
27	B-	Jakarta	4,33
28	B-	Dubai	4,29
29	C	Johannesburg — Ekurhuleni	4,01
30	C	Cairo	3,38

Note: Sum of normalized values is used in Total Score

Figure 1b.
Final Rating of Agglomerations of BRICS+

Rank	Agglomeration	Total Score
1	Moscow	7,20
2	Shanghai	6,92
3	St. Petersburg	6,88
4	Beijing	6,67
5	Guangzhou — Foshan	6,42
6	Shenzhen	5,66
7	Buenos Aires	5,61
8	Mumbai	5,43
9	Sao Paulo	5,29
10	Delhi	4,82
11	Riyad	4,74
12	Rio de Janeiro	4,68
13	Tehran	4,38
14	Dubai	4,29
15	Johannesburg — Ekurhuleni	4,01
16	Cairo	3,38

Note: Sum of normalized values is used in Total Score



II Methodology

II a Selection of Cities for Analysis

II b Determination of Urban Boundaries

II c Selection of Indicators

II c.1 Theoretical Framework 1 Accessibility of Services & Innovativeness of the City

II c.2 Theoretical Framework 2 Physical Accessibility & Diversity of the Urban Environment

II d Calculating of the Final Rating

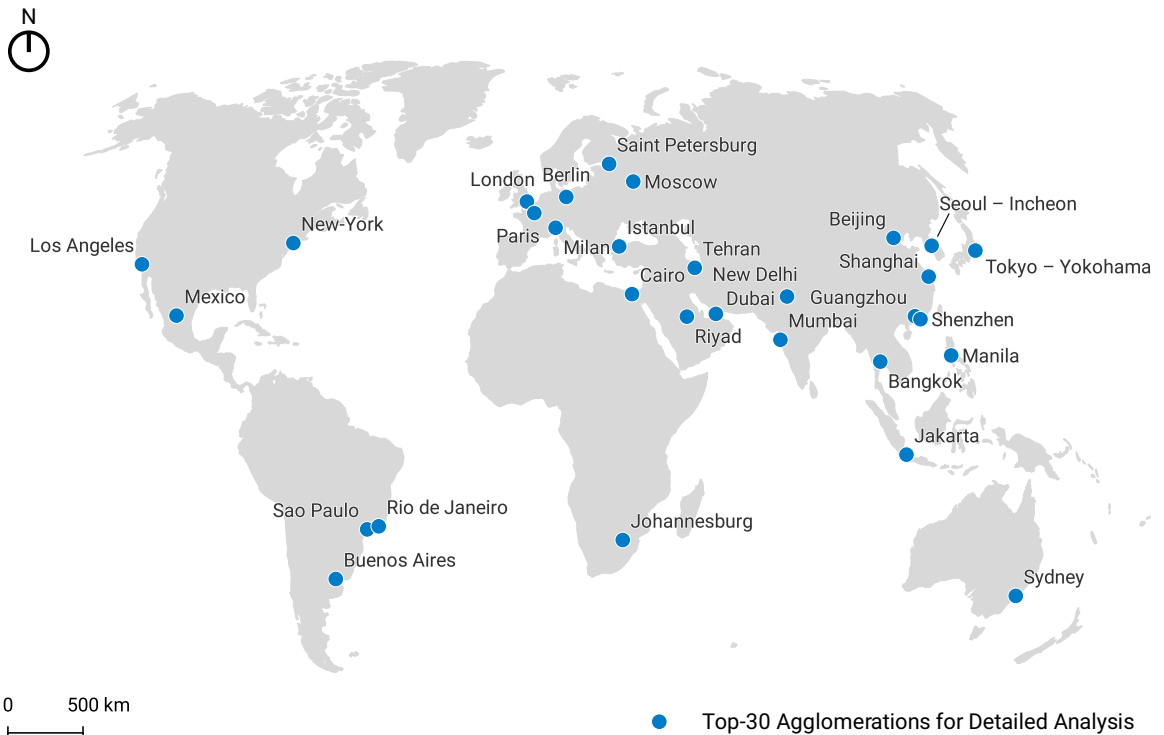
Selection of Cities for Analysis

Once we explored data availability for the 100 largest agglomerations in the world, we singled out the top 30 that we used to do research. The world's largest agglomerations were ranked by data availability based on the Demographia World Urban Areas report (Demographia World Urban Areas, 2023). It considers urban agglomerations as single built-up areas, an approach that we also employed in our study.

We intend to ensure the representation of world cities from different continents and parts of the world with the help of our Index and the resulting ranking; that is our major goal. We are also including cities that are often not taken into account due to the lack of comparable statistics. This goal setting determined the algorithm for selecting the final sample of cities for a detailed assessment.

The algorithm included **three sequential methods**: 1) quotas; 2) criteria-based selection; 3) expert assessment of the significance of the city in the global settlement system.

Figure 2.
Map of the agglomerations



Quotas were based on two parameters: BRICS status (half of the 30 cities selected must represent the BRICS+ bloc); urban population in each part of the world (% of the total population in the world).

For the **criteria-based selection** of agglomerations, we applied expert and quantitative criteria, including the results of quotas and assignment of agglomerations to a quota category (part of the world and the BRICS / BRICS+ bloc); size of the urban agglomeration according to open data; and country (for better representation of different countries).

Then we selected agglomerations with the **largest population** within the allocated quotas, ensuring the maximum diversity of the countries represented. If a country had roughly equally populated agglomerations, we would opt for the **capital city**.

We have generated a final sample of 30 cities according to the selection results, of which 15 are located in Asia, 2 in Africa, 6 in Europe, 3 in North America, 3 in South America, and 1 in Australia and Oceania.

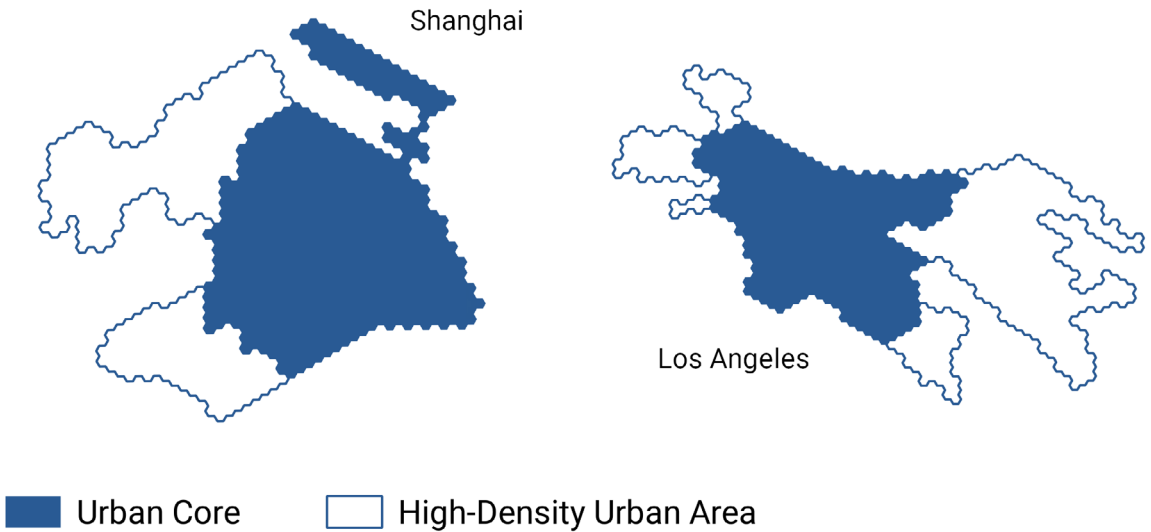
II b **Determination of Urban Boundaries**

We are moving away from viewing the city within its official boundaries; it is a pillar of the methodology used in this research. Administrative boundaries in many countries of the world have little to do with the actual configuration of built-up areas, and the difference in approaches to administrative structure makes it difficult to compare such areas (Kasanko et al., 2006). In addition, the largest cities have formed agglomerations with the settlements they developed from (Brühlhart & Sbergami, 2009; Rice, Venables, & Patacchini, 2006). The central city is the proverbial tip of the iceberg, and it is not enough for a comprehensive analysis. This is why most comparative international studies of cities have limited potential for interpretation and usability because they view cities within their administrative boundaries (Nakamura, 2008).

We used multi-criteria spatial analysis to define the boundaries of agglomerations that are interpreted as **high-density urban areas** under this research. To define them, we looked for continuous urban or suburban development and increased population density relative to the surrounding territory.

We also located **urban cores**, i.e., areas with the highest share of developed areas and population within high-density urban areas. Each city had specific indicator thresholds that were determined with descriptive statistics tools. Doing so, we defined the boundaries of two zones for each city: the urban core and the high-density urban area.

Figure 3.
Determination of Urban Boundaries:
Examples of Shanghai and Los Angeles



II c Selection of Indicators

The Index is based on two sets of indicators: **Accessibility of Services & Innovativeness of the City**; **Physical Accessibility & Diversity of the Urban Environment**. Together, they help delve into passive and active accessibility within the boundaries of agglomerations. Each set includes six basic indicators, and some feature nested variables. We used widely known and well-established methodological approaches to calculate most variables, a method that made the results more reliable and interpretable.

II c.1 Theoretical Framework 1 Accessibility of Services & Innovativeness of the City

Accessibility of Services & Innovativeness of the City is based on the Innovative and Creative Potential and Mobility-As-A-Service groups of indicators. We summed up the final values according to the availability, variety, and quality of required accessible infrastructure; financial accessibility of the related services for citizens; and the number of service users.

Key data sources: Statista; Numbeo; OpenStreetMap (OSM); international surveys and indices from UN organizations: E-Government Development Index (UN E-Government Knowledgebase, 2022), Integrated Index for Postal Development (UPU, 2022); Global Innovation Index from the World Intellectual Property Organization (WIPO, 2022).

When it comes to this set of indicators, the major challenge was the data used, as it largely contained information about the country in general, whereas we tackle a city and an agglomeration. This is why we introduced a correction factor for 30 selected agglomerations: the deviation of population values from the distribution according to Zipf's rule, where the population of a city is compared with its rank in the country-wide settlement system.

Mobility-as-a-Service Group of indicators

— INDICATOR 1

Development of Sharing Services

The sharing economy is changing our understanding of the availability of urban infrastructure. People share resources and services instead of buying them. This promotes the diversification of urban mobility, offers residents new experiences and opportunities (The Economist, 2013), reduces dependence on private cars, and eases the burden on public transportation. Short-term vehicle rental services boost flexibility and agility, allowing citizens to choose transportation according to their preferences and needs. There are two different types of sharing services: individual (personal mobility devices) and collective (cars), a division that we factored in for our list of variables.

We selected three aspects of the availability of sharing services for analysis: sector income, prevalence of services among users, and the immediate availability and diversity of services in the city.

The indicator includes five variables:

- **Variety of sharing travel services.**

Available services for short-term rental of a car, electric scooter, bicycle, and moped (or electric bicycle).

- **Revenue of companies providing bike sharing services.**

Bicycle sharing includes both electric sharing bicycles that require a designated parking space and free-floating bicycles (without a fixed parking place).

- **Revenue of companies providing car sharing services.**
The analysis included vehicles with and without a designated parking space. This leaves out long-term car rentals and special driving services (taxi, ride sharing).
- **Coverage of bike sharing service users.**
The percentage of customers from the country's population who have made at least one trip on a shared bike.
- **Coverage of car sharing service users.**
The percentage of customers from the country's population who have made at least one trip in a shared car.

— INDICATOR 2

Development of Delivery Services (Goods & Food)

With the development of technology and new services, takeout food and goods delivery is now faster and more accessible than ever, saving a lot of time and resources. City residents do not have to go shopping or cook food because they can deliver everything to their homes or to a pick-up point, freeing up enough time to do other things. Diverse and widespread delivery options boost economic development and urban change, because they increase consumption and market supply.

The indicator includes six variables:

- **Revenue of takeout food delivery companies.**
Total revenue of food delivery companies in the country, adjusted to the agglomeration level.
- **Takeout food delivery service coverage.**
The percentage of customers from the country's population who made at least one purchase on an e-commerce platform for the delivery of takeout food.
- **Revenue of grocery delivery companies.**
Total revenue of grocery delivery companies in the country, adjusted to the agglomeration level.
- **Grocery delivery service coverage.**
Percentage of customers in the country's population who have made at least one purchase on an e-commerce platform for grocery delivery.
- **Integrated Index for Postal Development.**
The index for the development of postal services in the country.
- **Major delivery companies present in the country's market.**
The number of large international companies you can use to send a parcel worldwide.

— INDICATOR 3

Development of Taxi Services

Uber's entry into the taxi market revolutionized the industry as passengers can now book rides and pay for them through a special, smartphone-based app. This Uberization of the taxi industry has significantly changed the approach to moving around the city. Citizens now save time calling a cab via their mobile devices, so they can now diversify their trips around the city, changing their mobility models and directions.

The indicator includes three variables:

- **Taxi revenue.**

Total revenue of the leading taxi companies in the market.

- **Coverage of taxi service users.**

The percentage of potential customers from the country's population who have made at least one trip by taxi.

- **Average cost of a taxi trip for a city dweller.**

The price of a taxi ride adjusted for the purchasing power of the city population.

Potential for Innovation Group of indicators

— INDICATOR 4

Scientific Potential

The scientific potential and propensity to innovate are important factors for the development of the economy and society, and as such, they require large research centers and highly skilled young innovators.

The indicator includes five variables:

- **Number of start-ups per capita.**

The number of start-ups registered in the city, adjusted for the number of people living in the agglomeration.

- **Number of patents issued.**

A total number of registered patents issued across the country.

- **Number of universities from the THE ranking.**

A total number of higher education institutions in the agglomeration featured in the ranking.

- **Number of students studying under a full-time equivalent course load.**

- **Ratio of the number of Higher Education Institutions in the agglomeration to the number of Higher Education Institutions in the country from the THE ranking.**

— INDICATOR 5

Cultural Potential

The cultural sphere is the underlying factor of the creative city economy. Cultural events attract tourists and locals, creating demand for goods and services, inspiring them to reinvest their free time in leisure and self-education. Culture is the driving force of the city's intellectual and innovative potential, the backbone of a creative class (Florida, 2002).

The indicator includes two variables:

- **Diversity of cultural institutions in the agglomeration.** To calculate the diversity indicator, the Herfindahl-Hirschman index is used, calculated by the number of cultural objects of different categories.
- **Availability of cultural institutions.** The number of cultural institutions per 10 thousand people living in the agglomeration.

— INDICATOR 6

Innovation Support: Development of Government Public Services

Digital technology and online services improves public service delivery, boost digital literacy and competencies of citizens, and makes for transparent and efficient government bodies (Gil-Garcia & Martinez-Moyano, 2007). Digital technology speed up document processing, cut red tape, and reduce bribery and corruption risks (Andersen, 2009), factors that increase citizens' trust in government bodies and contribute to economic development. They also automate some routine procedures, effectively saving time.

This indicator includes five variables:

- **Median upload speed** for the most popular mobile Internet providers in the city.
- **Median download speed** for the most popular mobile Internet providers in the city.
- **Index of public online service development.**
A countrywide indicator (Online Services Index), based on survey data.
- **Index of state telecommunications infrastructure development.**
A countrywide indicator (Telecommunication Infrastructure Index), based on survey data.
- **Human Capital Development Index.**
A countrywide indicator (Human Capital Index), based on survey data.

Physical Accessibility & Diversity of the Urban Environment

Active accessibility saves a citizen's time with abundant urban environment functions and service facilities, transportation accessibility, and the diversity of the city. These three aspects identified resulted in three groups of indicators: Balance of Spatial Development, Transportation Accessibility, Diversity of the Urban Environment.

The framework's indicators were assessed using spatial analysis of open geodata and the results of satellite image processing. These tools speak to the innovativeness of the Index developed under this research. They can also switch from the scale of an agglomeration to the scale of individual built-up areas and city districts, a feature that can benefit urban consulting and development level assessment for individual areas.

Main data sources: topology of the road network and localization of buildings and points of interest (POI) according to OpenStreetMap (OSM) data; population distribution according to WorldPop Data; land use type according to Dynamic World, (Brown et al., 2022) and open satellite imagery. We also used separate data sets from the official portals (websites) of the analyzed cities to verify the data.

The data used poses some challenges because it is incomplete, albeit verified comprehensively with statistical metrics; it is also inconsistent when it comes to the distribution of population across agglomeration areas, typical for regions with high migration and mobility of the population and for areas with uneven housing development.

Key advantages: consistent data logic that enables agglomerations to be compared with each other and the real-time updateability of many datasets.

Balance of Spatial Development

Group of indicators

— INDICATOR 1

Level of Polycentricity

Polycentricity means functions concentrated at certain points within the city (Veneri, 2013), creating a more balanced spatial structure. A polycentric city means that many residents can quickly and easily reach places where urban activity is concentrated and use services, resources, and opportunities. It saves time, improves the quality of life, and reduces the load on transportation infrastructure.

The indicator describes the spatial structure of the city by analyzing the configuration and diversity of urban nuclei. Urban nuclei generate sustainable flows of people by attracting the population with trade, services, recreation, and culture. Urban nuclei are singled out independently from the urban core and its high-density urban area, so we can assess its significance for each agglomeration zone. Nuclei are identified using spatial analytical models based on the statistical significance of concentrations of functions in individual urban areas.

- [Share of the Population Living within Walking Distance from Urban Nuclei variable.](#)

— INDICATOR 2

Functional Diversity of Suburbs

We use a similar identification algorithm to study the spatial structure of a high-density urban area outside the urban core. The algorithm statistically assesses the extent of the sprawl of suburbs with no functions required within walking distance (urban sprawl) in the agglomeration. The rule of thumb is that suburban areas lack functions and are therefore exposed to the risks of marginalization.

- [Share of the Population Living within Walking Distance from Urban Nuclei in the Suburbs variable.](#)

Transport Accessibility

Group of indicators

— INDICATOR 3

Integration of the Road Network

The road network is the backbone of urban mobility. Its configuration ensures active and passive accessibility of the territory and can be described by various indicators, for example, its integration. According to Space Syntax methodological approach integration metrics measure the to-movement potentials of linear structures. The road network is what people use to get from one location to another; it shapes up travel opportunities, determines travel time, and defines available delivery, taxi, and sharing services.

- Median Integration in High-Density Area Borders Based on Street Network Configuration variable.

— INDICATOR 4

Public Transport Infrastructure

The accessibility of urban areas largely depends on how convenient and efficient public transportation is in various parts of the agglomeration. Public transportation reduces travel time between different parts of the city for its residents, providing fast and efficient travel options. Both indicators make it possible to comprehensively describe the two main patterns of urban mobility: individual and public transportation.

- Share of the Population Living within 500 Meters from Public Transport Stops variable.
- Share of the Population Living within 1000 Meters from Metro and Railway Stations variable.

Diversity of Built Environment

Group of indicators

— INDICATOR 5

Diversity of Urban Morphology Types

The diversity of urban morphology types fosters a unique urban environment conducive for satisfying even the polar opposite demands of citizens.

The calculation of the Diversity of Urban Morphology Types requires more than one step and involves two basic (Berghauser Pont & Haupt, 2007) variables according to Spacemate methodology: Ground Space Index (i.e., development density) and Open Space Ratio. The Ground Space Index represents the ratio of built-up and undeveloped areas. Areas with a higher density of development typically boast a higher population density and multiple places of employment and points of attraction. The Open Space Ratio calculates the intensity of use of undeveloped space by residents of the territory, complementing the previous variable. We chose a calculation approach by correlating the area of undeveloped space on the location in question with the number of people living on this location.

All territorial units were divided into 9 clusters according to the GSI and OSR values, as the backbone of our diversity assessment for built-up areas we used the Herfindahl-Hirschman index.

- [Inverted Herfindahl-Hirschman Index of Diversity of Urban Morphology variable.](#)

— INDICATOR 6

Accessibility of Green Spaces

Green spaces in a modern city directly influence the environment. They are also pillars of a comfortable urban environment (Klemm et al., 2015), a 15-minute city (Liu et al., 2022). They raise the quality of life by improving mental comfort and diversifying citizen leisure time (Wang et al., 2019).

The accessibility area of green spaces is interpreted as a buffer zone corresponding to an isochrone radius of 15 minutes from each green space. Such spaces are thick growths of trees or shrubs that span more than 0.5 hectares, recognized using neural networks from open satellite imagery.

- [Proportion of the Population Living within the Zone of 15-Minute Accessibility of Green Spaces variable](#)

Calculating of the Final Rating

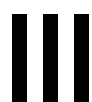
Indicators are basic analyzed elements of our methodological approach. 12 Indicators described below are grouped to two theoretical frameworks — **Accessibility of Services & Innovativeness of the City** and **Physical Accessibility & Diversity of the Urban Environment**. Some indicators are composite and include the internal variables specified in the section above.

A widely spread normalization procedure via standard deviation was used to calculate all **variables** and **non-composite indicators**. Thus, the maximum normalized value for every indicator is 1.0. **Composite indicators**, in turn, were calculated as the equal-weight sums of the internal variables.

For **non-composite indicators** (these are indicators 1, 2, 3, 4, 6 of the **Physical Accessibility & Diversity of the Urban Environment** Theoretical Framework), the maximum value of 1.0 does not mean the maximum possible value for the analyzed indicators. Individual maps for the leading cities show the real values of indicators measured using spatial analysis methods.

The Final Rating of agglomerations (Fig. 1) is calculated as the sum of the sub-ratings according to Theoretical Frameworks. Sub-ratings are also calculated as the sum of the corresponding indicators. The standard limitation is that the indicator values may not sum to total due to rounding.





Accessibility of Services & Innovativeness of the City

Figure 4.
Determination of Urban Boundaries:
Examples of Delhi and Manila

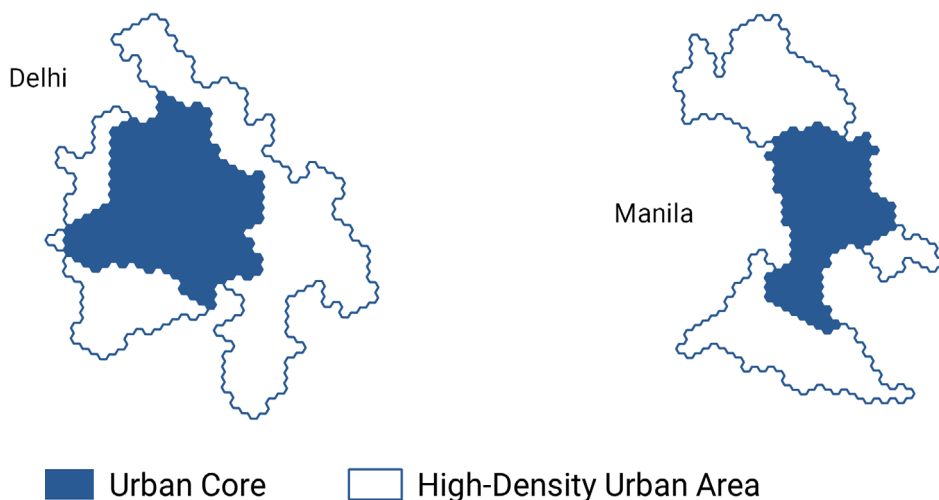
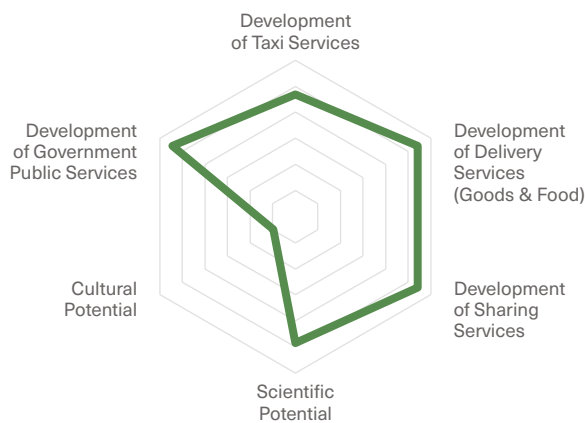


Figure 5.
Ranked list of agglomerations according to the Theoretical Framework 1

Rank	Agglomeration	Set's of Indicators Score
1	Seoul — Incheon	3,51
2	London	3,29
3	Shanghai	3,04
4	Tokyo — Yokohama	2,96
5	Los Angeles	2,89
6	Berlin	2,86
7	Beijing	2,86
8	New York	2,85
9	Guangzhou — Foshan	2,71
10	Milan	2,58
11	Paris	2,55
12	Sydney	2,44
13	Shenzhen	2,40
14	Dubai	2,39
15	Moscow	2,22
16	Riyad	2,07
17	Buenos Aires	2,06
18	Sao Paulo	2,06
19	St. Petersburg	2,02
20	Bangkok	1,91
21	Istanbul	1,89
22	Rio de Janeiro	1,88
23	Mexico	1,80
24	Jakarta	1,64
25	Delhi	1,49
26	Cairo	1,49
27	Mumbai	1,45
28	Tehran	1,30
29	Manila	1,24
30	Johannesburg — Ekurhuleni	1,20

Figure 6.
Profiles of Leading Agglomerations

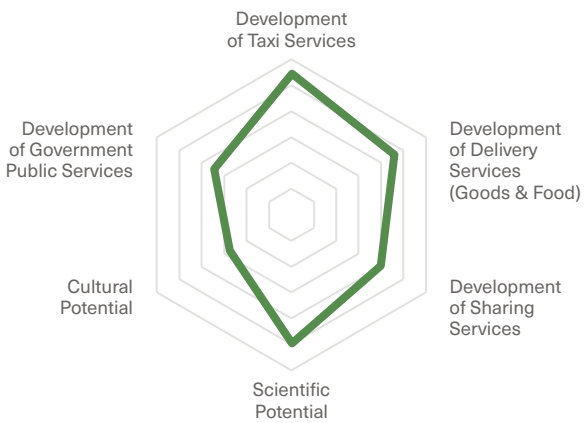
Seoul — Incheon



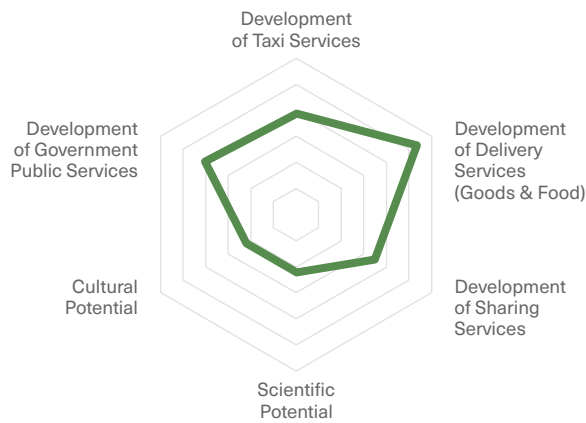
Tokyo — Yokohama



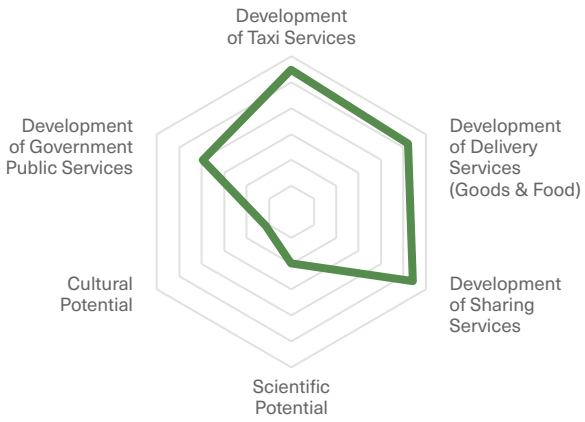
London



Los Angeles



Shanghai



Berlin

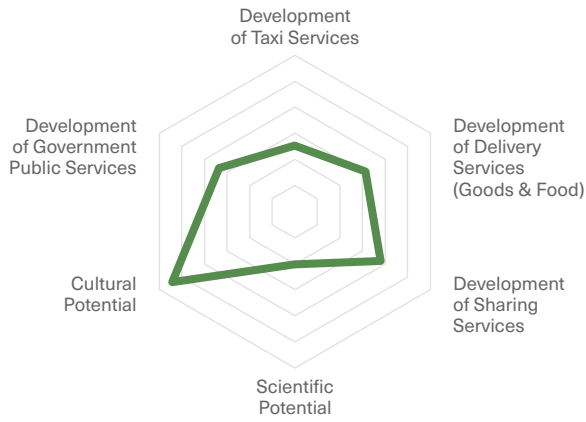
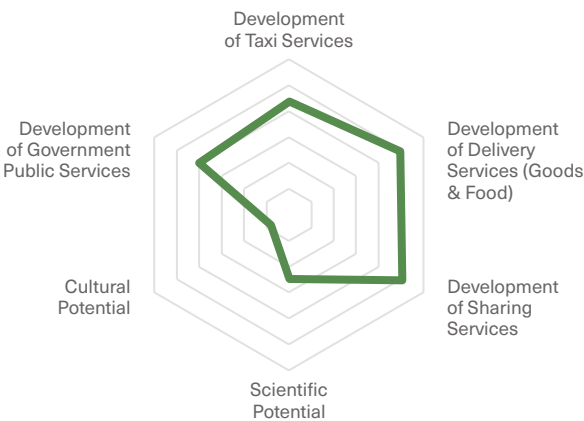
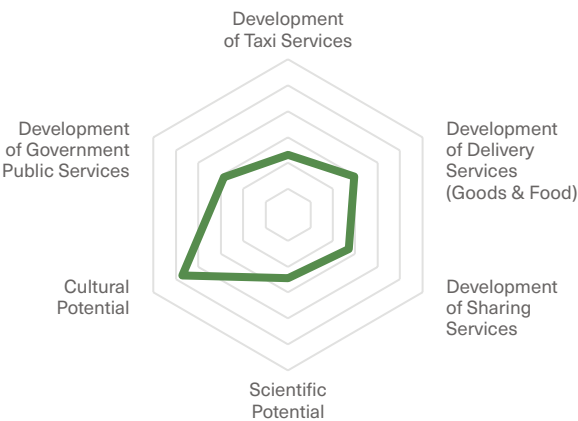


Figure 6 (in continuation).
Profiles of Leading Agglomerations

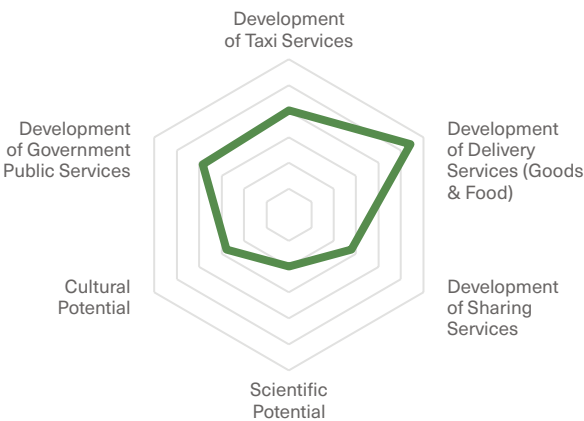
Beijing



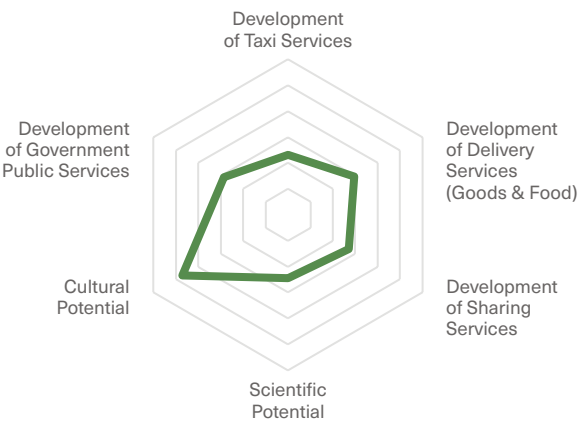
Paris



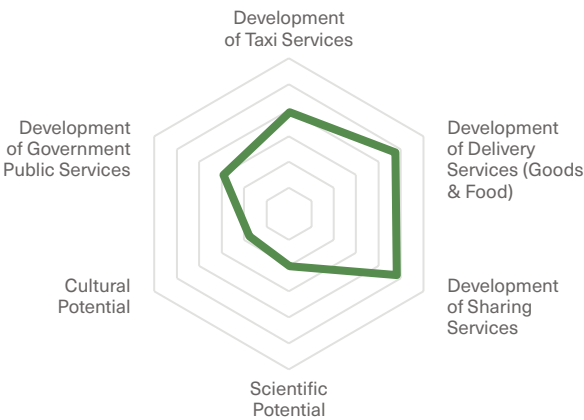
New York



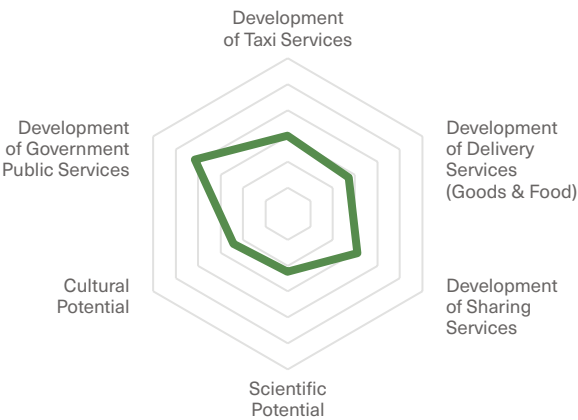
Paris



Guangzhou



Sydney



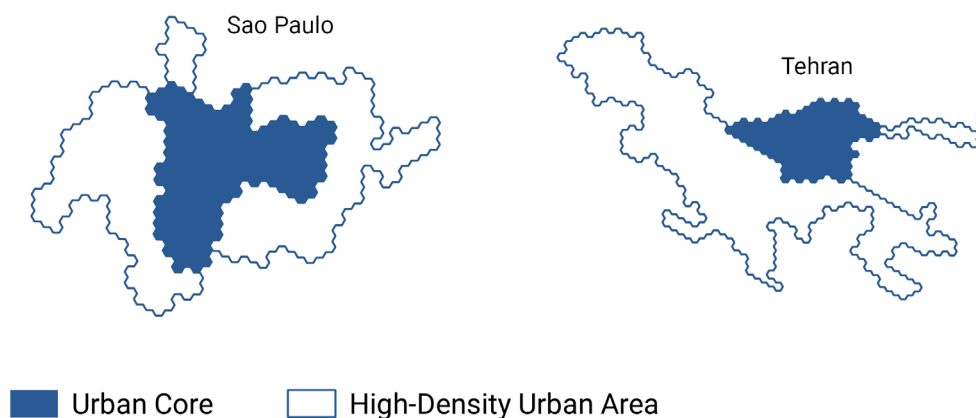
Group of Indicators 1

Mobility-as-a-Service

— INDICATOR 1

Development of Sharing Services

Figure 7:
Determination of Urban Boundaries:
Examples of Sao Paulo and Tehran



Results Overview

Shared micromobility optimizes urban mobility and allows people to choose vehicles according to their individual preferences and specific needs. It saves citizens' time and improves the quality of travel. The sharing economy is a relatively new market: in many countries it has not established itself as a resilient economic sector yet. Around the world there are different types and forms of sharing services. For example, carsharing has at least two widespread models that have different parking options. European countries have adopted a designated-parking-lot system, where a driver picks up and leaves a car like a sharing bike. In other countries system of carsharing differs: a driver can pick up and leave a car in any city parking. These minor distinctions could have a major influence on the mobility systems. Assessing the topic, we take the country-specific details into account.

In our Index, Seoul and Shanghai, urban agglomerations in East Asia, lead in the development of sharing services. They are followed by the agglomerations outside of East Asia — Milan, London, and Berlin, ranking 6th, 7th, and 8th respectively. Milan has a high score due to a diverse history of sharing service development, in particular, cars. Italy introduced carsharing in early 2010, offering a relatively low price for it: about 0.3 euros per minute.

Most of the agglomerations having a sharing service availability score ranged from 0,20 to 0,45. Typical issues in this group are the following: a high rate of vehicle ownership and a low demand for carsharing. Moreover, the street network and road infrastructure are often not adapted for convenient movement with the use of micromobility vehicles.

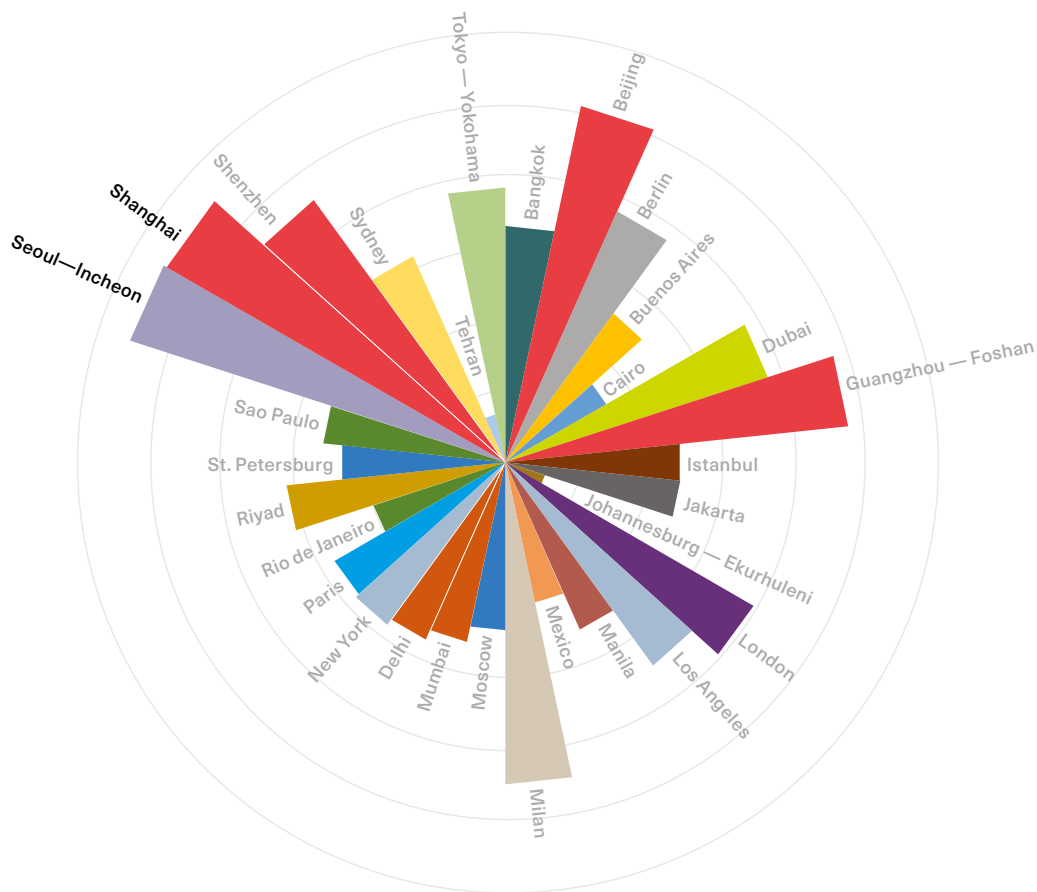
The lowest scores on this indicator are due to the low penetration of especially carsharing and bike sharing services, as well as due to low revenues from these services, according to official data.

Figure 8.
Development of Sharing Services

Rank	Agglomeration	Indicator's Score
1	Seoul — Incheon	0,65
2	Shanghai	0,64
3	Beijing	0,60
4	Guangzhou — Foshan	0,57
5	Shenzhen	0,54
6	Milan	0,53
7	London	0,47
8	Dubai	0,45
9	Tokyo — Yokohama	0,45
10	Berlin	0,45
11	Los Angeles	0,41
12	Bangkok	0,39
13	Sydney	0,37
14	Riyad	0,36
15	New York	0,33
16	Paris	0,32
17	Delhi	0,32
18	Buenos Aires	0,30
19	Mumbai	0,30
20	Sao Paulo	0,30
21	Manila	0,30
22	Jakarta	0,29
23	Istanbul	0,29
24	Moscow	0,27
25	St. Petersburg	0,27
26	Mexico	0,23
27	Rio de Janeiro	0,22
28	Cairo	0,19
29	Tehran	0,08
30	Johannesburg — Ekurhuleni	0,06

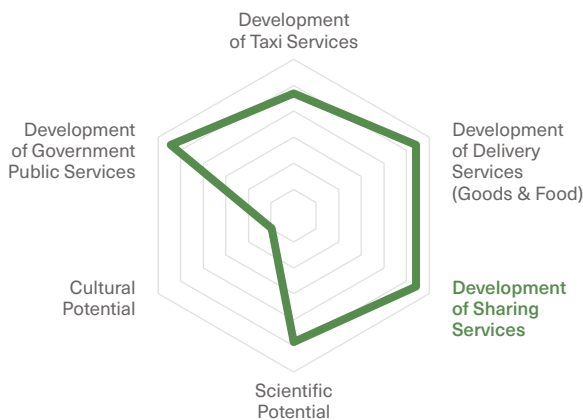
Note: May not sum to total due to rounding

Figure 9.
Development of Sharing Services

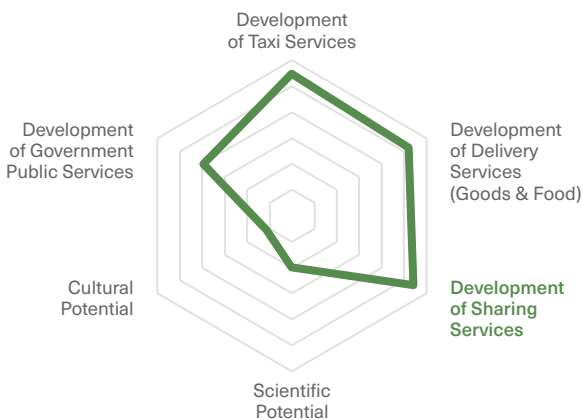


In the leading agglomerations we can observe a relatively balanced development of the entire Mobility-as-a-Service system. Digital competencies and the ability to use digital services are becoming an important factor.

Seoul — Incheon



Shanghai

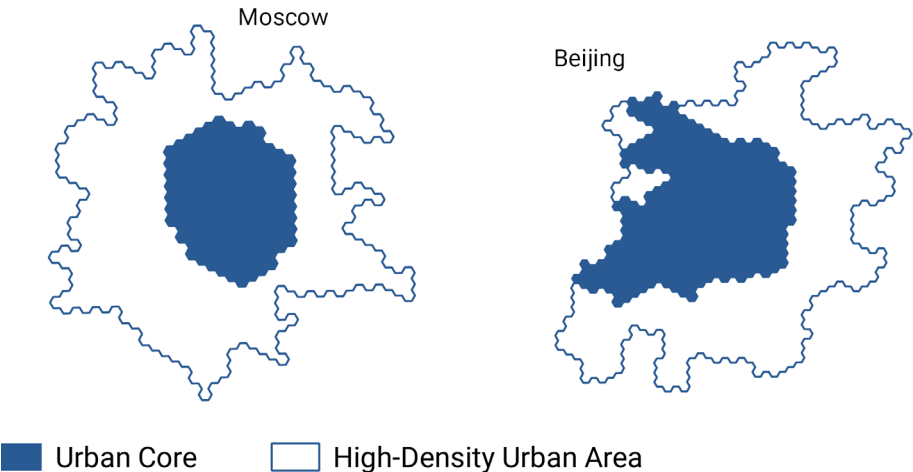




— INDICATOR 2

Development of Delivery Services (Goods & Food)

Figure 10:
Determination of Urban Boundaries:
Examples of Moscow and Beijing



Results Overview

Food and goods delivery is a significant aspect of modern urban social and economic life. They create an additional distribution channel and boost income for restaurants and culinary businesses, change the spatial structure of the cities due to the implementation of new infrastructural elements like dark kitchens. Food and goods delivery services could diversify the types of resources available to the urban population in the context of growing urbanization. They save citizens' time and provide diverse options for reinvesting it.

Together with cultural and scientific potential, the development of delivery services is one of the most varied indicators of total scores: there is a notable gap between the agglomerations in the first and the second half of the rank, between the front-runners and laggards. New York and Los Angeles, two representatives of North America, and Seoul-Incheon, Shanghai and Beijing, three East Asian agglomerations, come out on top. The following agglomerations: London, Guangzhou-Foshan, Tokyo-Yokohama, Shenzhen. This could be explained by the rapid digitalization, the historical tradition of home delivery of goods and products, support of high-tech and delivery industries in the national economy.

The middle scores on this indicator range from 0,23 to 0,44. This is a diverse group represented by agglomerations in Western Europe, Russia, the agglomerations of the Persian Gulf, South Asia, and Southeast Asia. The results emphasize the need for a country-specific research design.

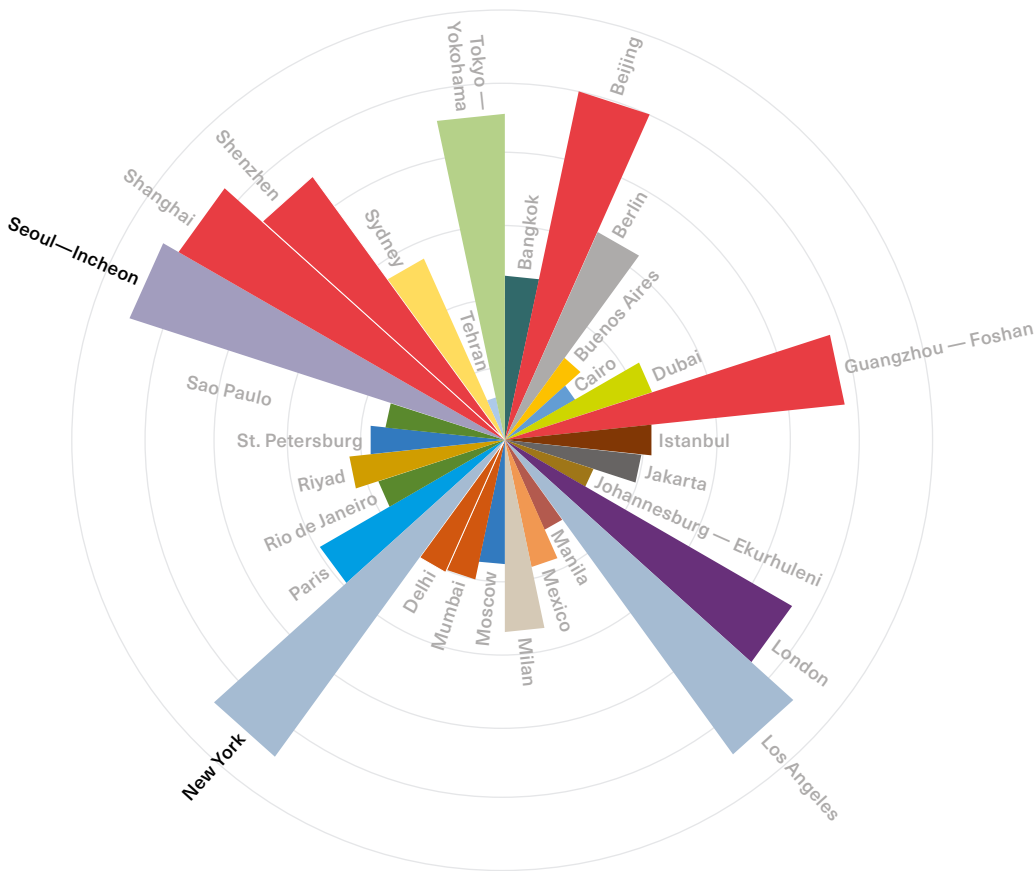
Main reasons for the lowest and sometimes middle scores for the delivery services include high delivery prices, local traditions including eating out habits and home cooking, lowest level of digitalization and socio-economic inequality.

Figure 11.
Development of Delivery Services (Goods & Food)

Rank	Agglomeration	Indicator's Score
1	Seoul — Incheon	0,78
2	New York	0,78
3	Los Angeles	0,77
4	Shanghai	0,75
5	Beijing	0,71
6	Guangzhou — Foshan	0,68
7	London	0,66
8	Shenzhen	0,65
9	Tokyo — Yokohama	0,65
10	Berlin	0,46
11	Paris	0,43
12	Sydney	0,40
13	Milan	0,39
14	Bangkok	0,34
15	Riyad	0,32
16	Dubai	0,32
17	Istanbul	0,31
18	Delhi	0,30
19	Mumbai	0,30
20	Jakarta	0,29
21	St. Petersburg	0,28
22	Rio de Janeiro	0,28
23	Mexico	0,27
24	Moscow	0,26
25	Sao Paulo	0,25
26	Buenos Aires	0,22
27	Manila	0,21
28	Johannesburg — Ekurhuleni	0,20
29	Cairo	0,18
30	Tehran	0,10

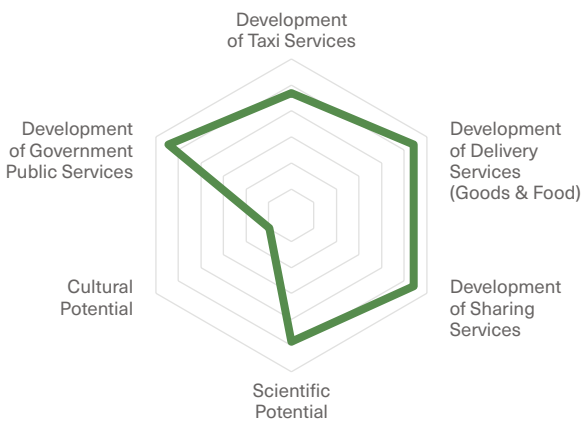
Note: May not sum to total due to rounding

Figure 12.
Development of Delivery Services (Goods & Food)

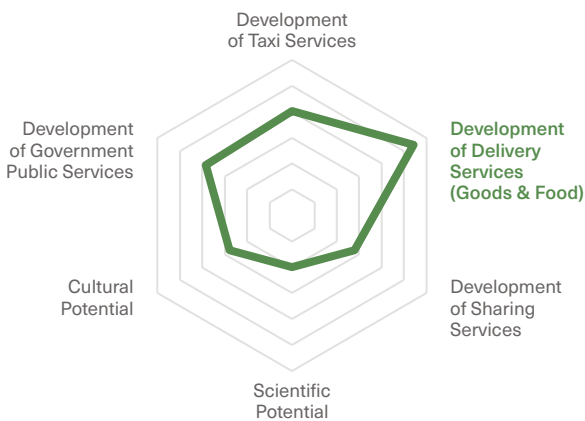


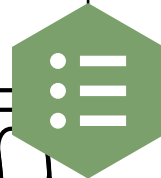
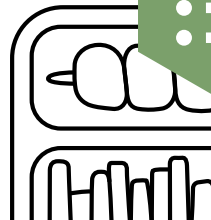
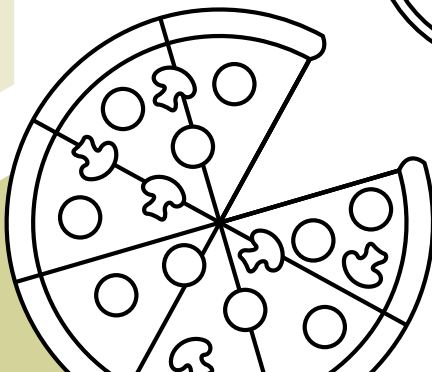
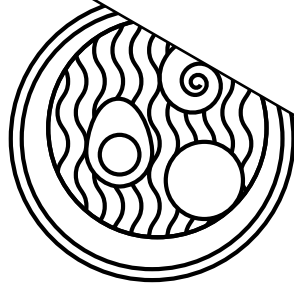
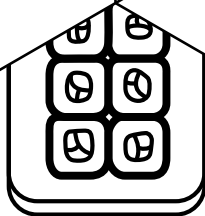
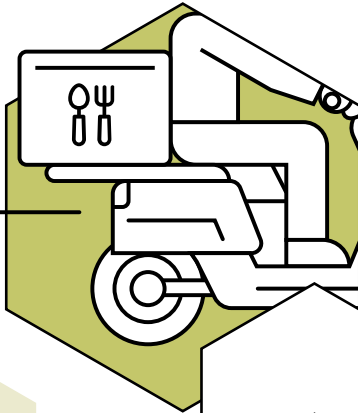
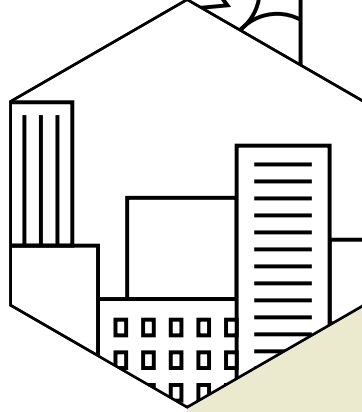
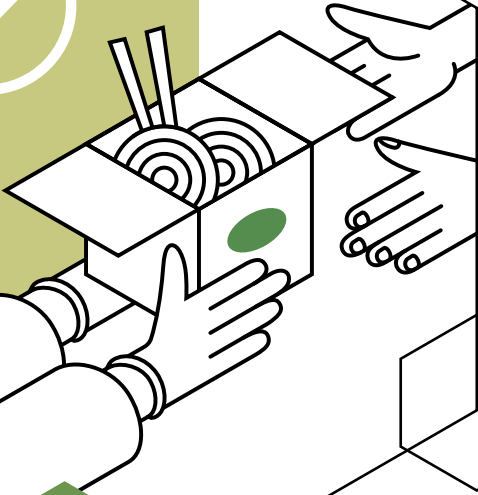
Chinese, American, Korean and Japanese agglomerations are the undisputed leaders in the prevalence of food and goods delivery.

Seoul — Incheon



New York



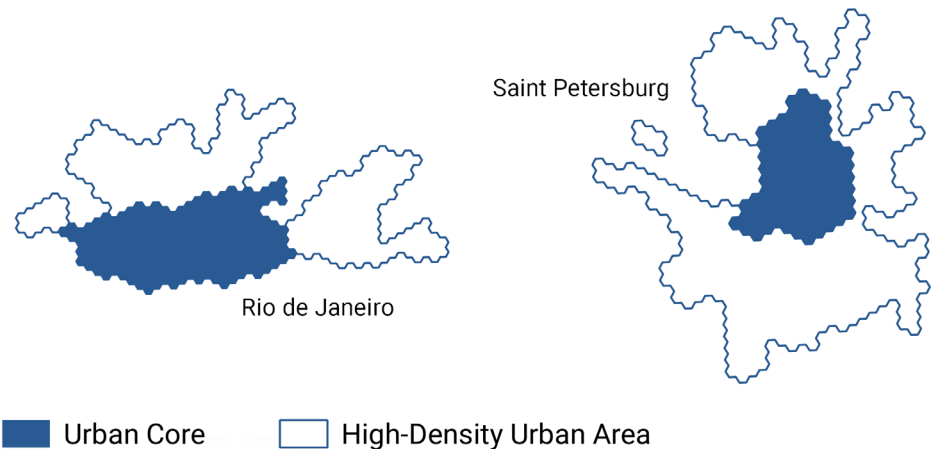


Group of Indicators 1
Mobility-as-a-Service

— INDICATOR 3

Development of Taxi Services

Figure 13:
Determination of Urban Boundaries:
Examples of Rio de Janeiro and Saint Petersburg



Results Overview

Together with public transport, taxi services are one of the most recognizable markers of urban mobility. They embody the inner-city processes: flexibility, digitalization, intensity and speed. Many cities create a recognizable color code for these vehicles: yellow cabs in New York City, orange in Seoul, black in London, cream-colored in Berlin, black-and-yellow in Mumbai. The taxi market also implements the common trends and quickly responds to the digitalization processes.

Among the other indicators in the group Mobility-As-A-Service, taxi services can be considered the least developed indicator in the selected agglomerations. This result can be explained by two factors. First, taxis replace the alternative services (a private car, carpool, public transportation, individual mobility devices, or walking). Second, all the agglomerations have a high vehicle ownership rate or a developed public transport system, which reduces the value of the taxi services in terms of the price-time ratio.

Shanghai and London are the leaders in this indicator, having one of the highest rates of taxi revenue and user penetration. Shanghai is one of the most digitalized metropolitan areas in China, and London has car-reduction policies in the historic city center. Seoul-Incheon, Beijing, Dubai, New York, Guangzhou-Foshan, Los Angeles, Milan also show high scores in the development of taxi services.

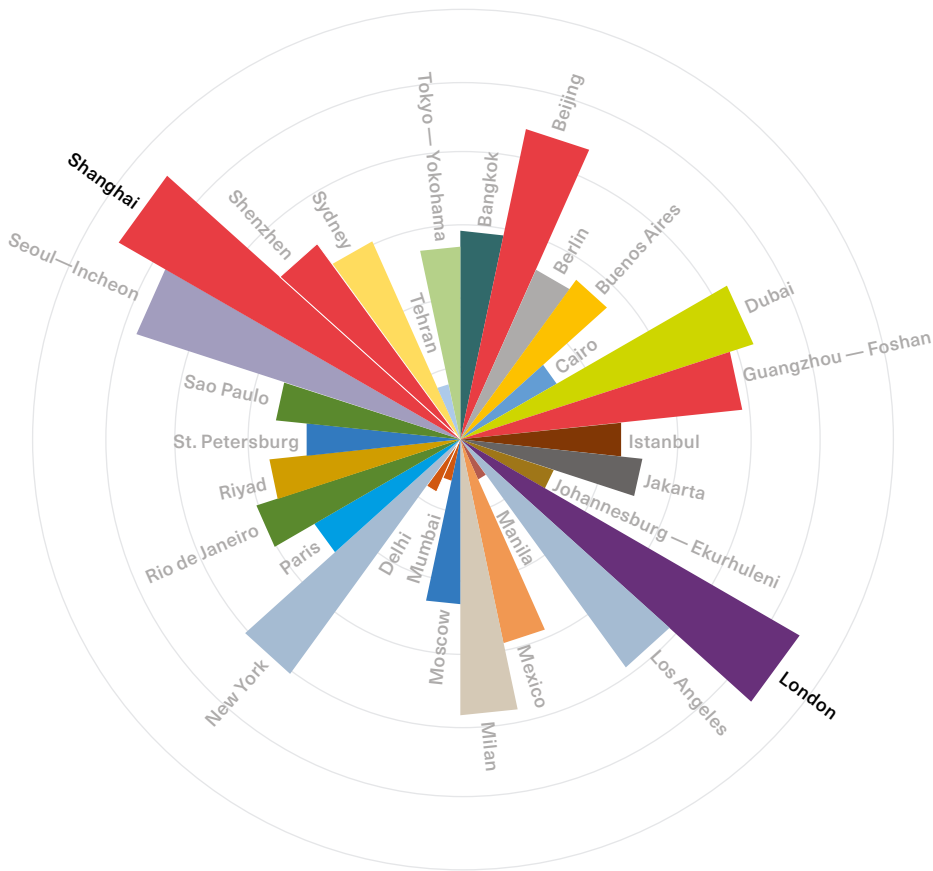
Milan, Rio de Janeiro, Paris, Sao Paulo agglomerations with middle scores of the development of taxi systems have a relatively high cost for it, compared to the purchasing power, or an accessible metro system.

Figure 14.
Development of Taxi Services

Rank	Agglomeration	Indicator's Score
1	Shanghai	0,56
2	London	0,56
3	Seoul — Incheon	0,49
4	Beijing	0,46
5	Dubai	0,45
6	New York	0,42
7	Guangzhou — Foshan	0,41
8	Los Angeles	0,41
9	Milan	0,40
10	Shenzhen	0,36
11	Sydney	0,33
12	Rio de Janeiro	0,32
13	Bangkok	0,32
14	Mexico	0,32
15	Buenos Aires	0,30
16	Tokyo — Yokohama	0,30
17	Riyad	0,29
18	Berlin	0,29
19	Sao Paulo	0,28
20	Jakarta	0,28
21	Paris	0,26
22	Moscow	0,26
23	Istanbul	0,25
24	St. Petersburg	0,24
25	Cairo	0,19
26	Johannesburg — Ekurhuleni	0,17
27	Delhi	0,12
28	Tehran	0,11
29	Manila	0,10
30	Mumbai	0,10

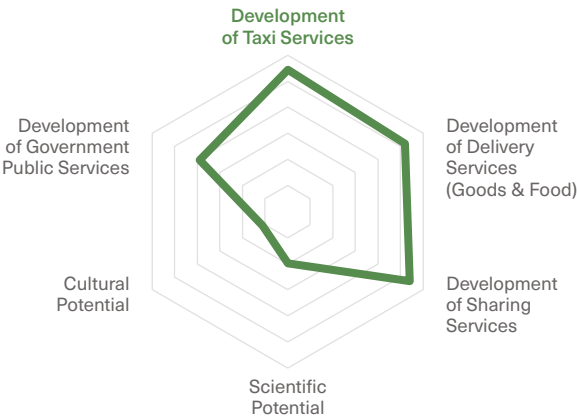
Note: May not sum to total due to rounding

Figure 15.
Development of Taxi Services

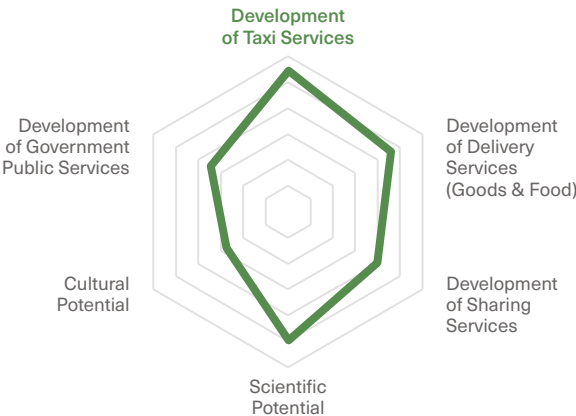


Taxi is the most conservative type of Mobility-as-a-Service.
The agglomerations of different countries received the highest ratings. Shanghai and London became the leaders in this indicator.

Shanghai



London

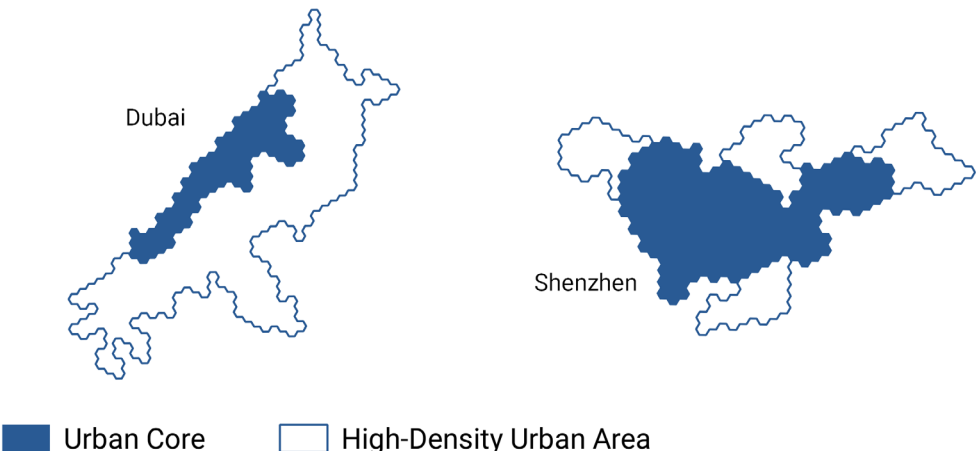




Group of Indicators 2
Potential for Innovation

— INDICATOR 4
Scientific Potential

Figure 16:
Determination of Urban Boundaries:
Examples of Dubai and Shenzhen



Results Overview

Universities, patent grants, and startups are an influential factor in modern economic development. They generate new market niches, stimulate market competition, facilitate the improvement of the products and quality of services, attract highly skilled specialists, and create new jobs. Also, they foster the innovation and scientific environment, accelerating urban processes and creating new time-saving services.

In total, the indicators of scientific potential are the lowest values among the group. There are at least three possible reasons behind this. First, the main scientific center is not a large or the largest agglomeration in most countries. For example, most of the prestigious American universities are located in small university towns; German higher education institutions are usually located in medium-sized and large cities in the southern part of the country, far from Berlin. Second, the international rankings of universities can be influenced by the development and internationalization level of the country's education system. Third, this indicator is influenced by the country's market structure and its openness to the network of international knowledge exchange.

The leading research centers are concentrated in Tokyo–Yokohama, Seoul–Incheon, London and Moscow. They significantly differ from other agglomerations in the total scores due to a balance of scientific, educational, and administrative processes.

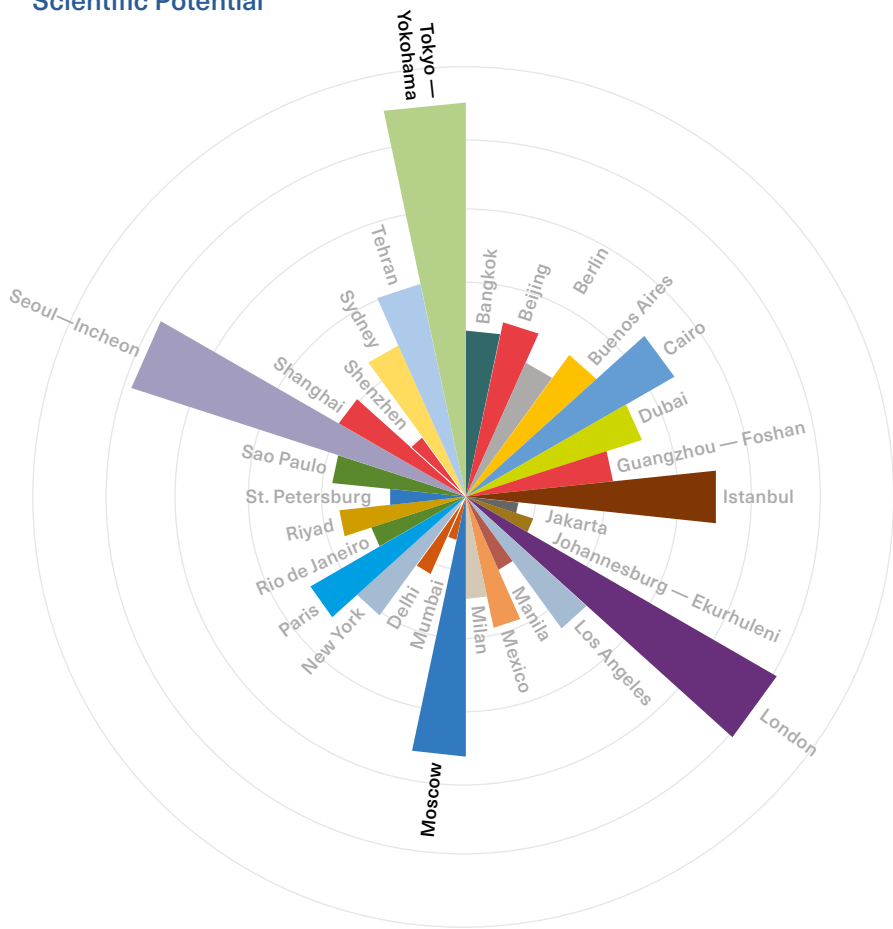
Agglomerations with average scores are represented by the economic centers like Beijing, Dubai, Buenos Aires. They attract students and scientists, providing diverse opportunities for socialization and knowledge exchange.

Figure 17.
Scientific Potential

Rank	Agglomeration	Indicator's Score
1	Tokyo — Yokohama	0,60
2	London	0,55
3	Seoul — Incheon	0,54
4	Moscow	0,39
5	Istanbul	0,38
6	Cairo	0,37
7	Tehran	0,33
8	Dubai	0,28
9	Paris	0,27
10	Beijing	0,27
11	Buenos Aires	0,27
12	Bangkok	0,25
13	Sydney	0,25
14	Los Angeles	0,25
15	Guangzhou — Foshan	0,22
16	Berlin	0,22
17	New York	0,22
18	Shanghai	0,22
19	Sao Paulo	0,20
20	Mexico	0,20
21	Riyad	0,19
22	Milan	0,15
23	Rio de Janeiro	0,15
24	Delhi	0,13
25	Manila	0,12
26	St. Petersburg	0,12
27	Shenzhen	0,11
28	Johannesburg — Ekurhuleni	0,11
29	Jakarta	0,08
30	Mumbai	0,07

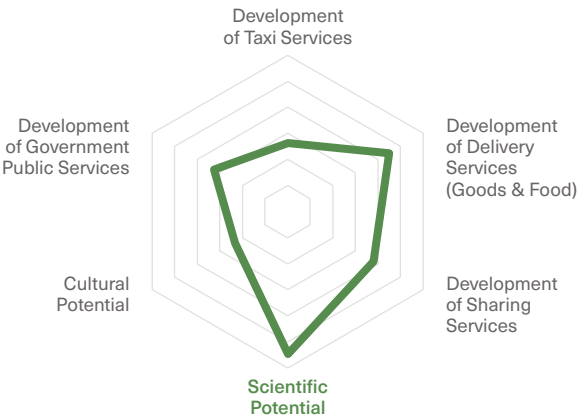
Note: May not sum to total due to rounding

Figure 18.
Scientific Potential

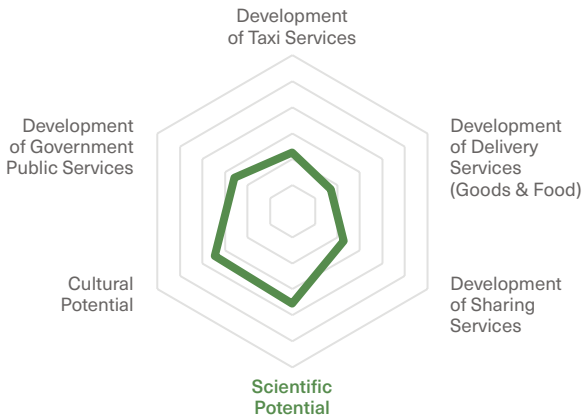


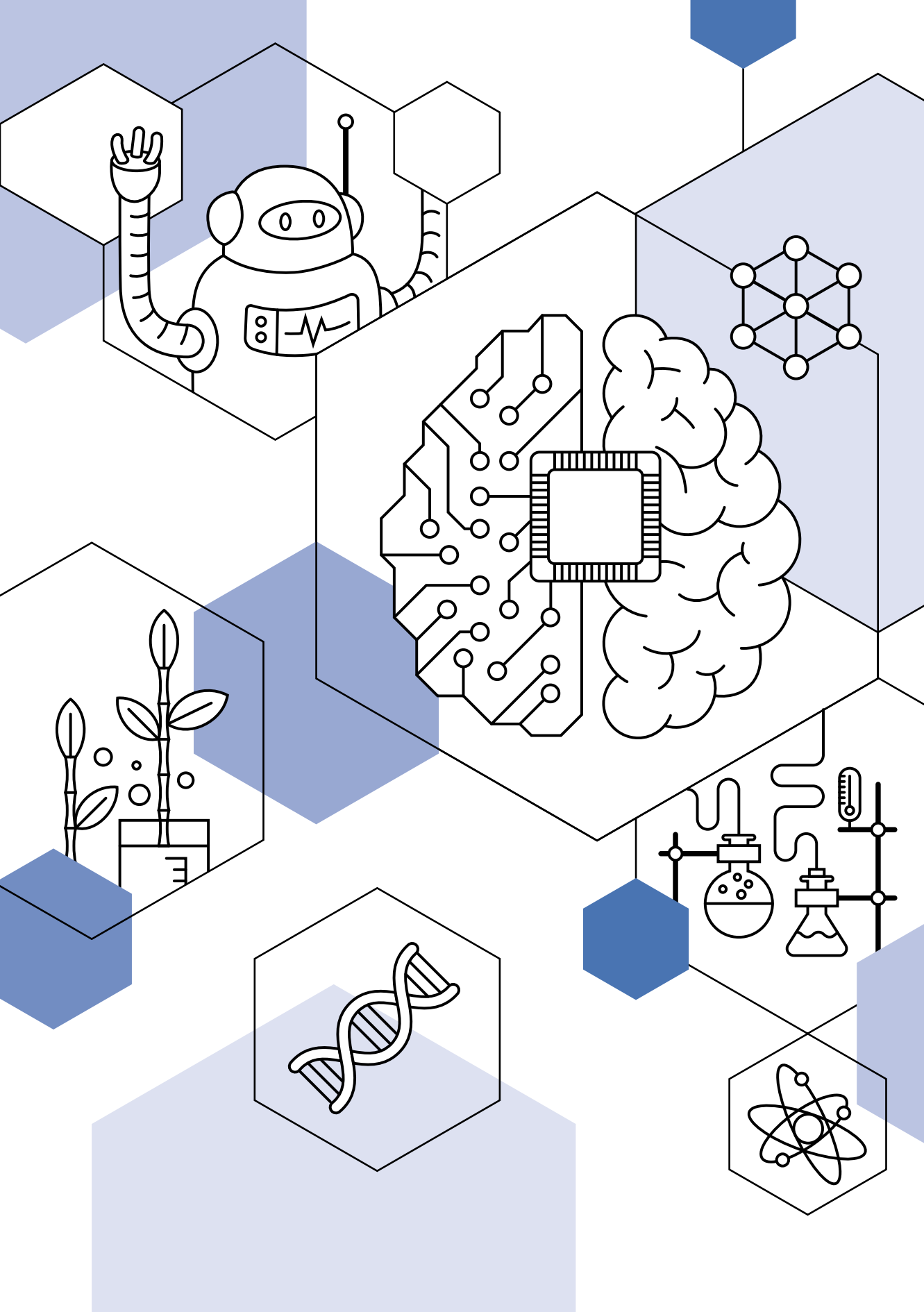
The level of scientific potential differs significantly between the analyzed agglomerations. Main reason is the concentration of scientific and educational organizations in the largest agglomerations, which is typical for Tokyo, Moscow, London, Seoul.

Tokyo — Yokohama



Moscow

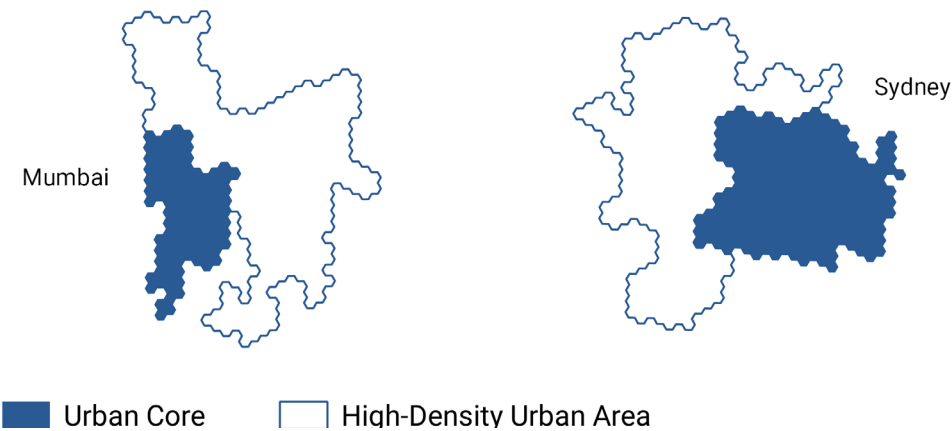




Group of Indicators 2
Potential for Innovation

— INDICATOR 5
Cultural Potential

Figure 19:
Determination of Urban Boundaries:
Examples of Mumbai and Sydney



Results Overview

Diversification of cultural institutions in the urban environment influences socio-cultural development: they generate a cultural landscape, preserve a cultural heritage, provide citizens with access to different forms of art, science, and education, promote social inclusion and foster community interaction, catalyze the development of creative and intellectual potential. Diverse cultural institutions ensure the sustainable and balanced development of society, fuel innovative development and increase the quality of time spent in the city.

Within the drawbacks of the other international cross-cultural indexes, researchers often mention the European and Eurocentric perspectives. This choice of research optics influence most of the ranking results: sample, indicators, aggregation methods and interpretation. Constructing this Index, we took this common disadvantage into account and tried to make our methodology and results comparable between the different countries and agglomeration context. Cultural potential is not an exception: in the spotlight are the diversification rate of institutions and availability of them for the agglomeration population.

Berlin and Paris stand out from the others, having the highest scores on the culture potential indicator. One of the explanations of this result could be the small agglomeration size, which influenced the calculations of the number of all the cultural institutions per person. Together with Saint Petersburg, Milan, Moscow, and London they notably differ from the other agglomerations on the Herfindahl-Hirschman index for the diversity in cultural institutions.

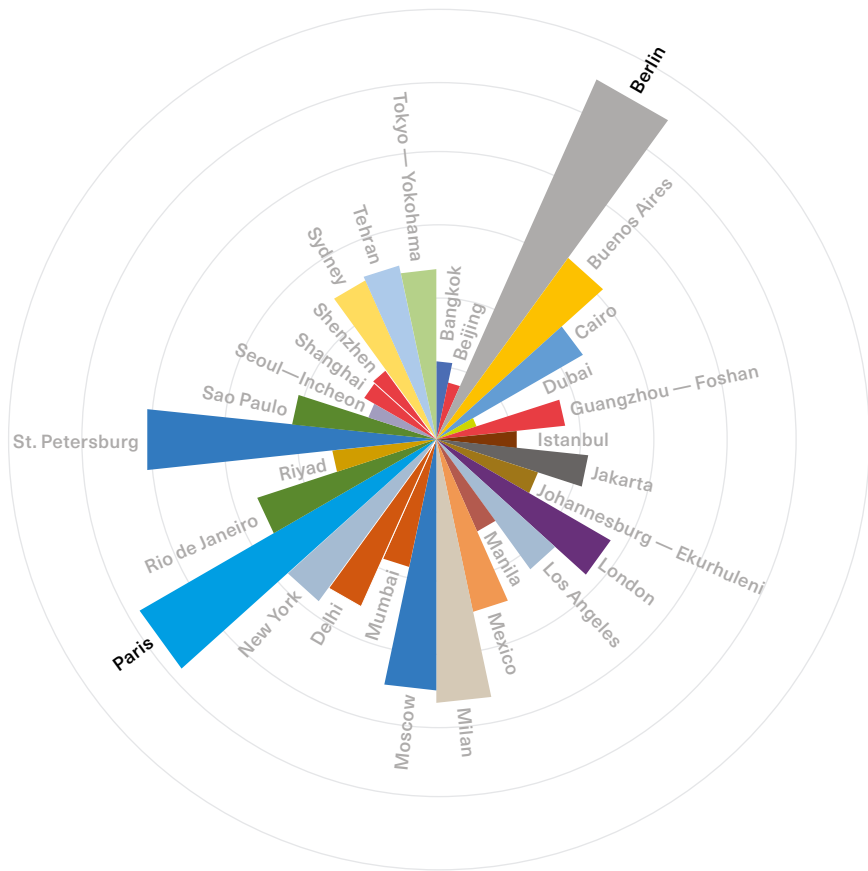
Agglomerations with middle scores drive the development of cultural industries or have a well-preserved historical cultural heritage.

Figure 20.
Cultural Potential

Rank	Agglomeration	Indicator's Score
1	Berlin	0,89
2	Paris	0,78
3	St. Petersburg	0,67
4	Milan	0,61
5	Moscow	0,58
6	Buenos Aires	0,53
7	London	0,48
8	New York	0,48
9	Rio de Janeiro	0,45
10	Delhi	0,44
11	Tehran	0,43
12	Mexico	0,43
13	Sydney	0,42
14	Tokyo — Yokohama	0,41
15	Cairo	0,41
16	Los Angeles	0,39
17	Jakarta	0,38
18	Sao Paulo	0,36
19	Mumbai	0,33
20	Guangzhou — Foshan	0,33
21	Johannesburg — Ekurhuleni	0,28
22	Riyad	0,28
23	Manila	0,27
24	Shenzhen	0,24
25	Shanghai	0,23
26	Istanbul	0,22
27	Bangkok	0,22
28	Seoul — Incheon	0,21
29	Beijing	0,18
30	Dubai	0,14

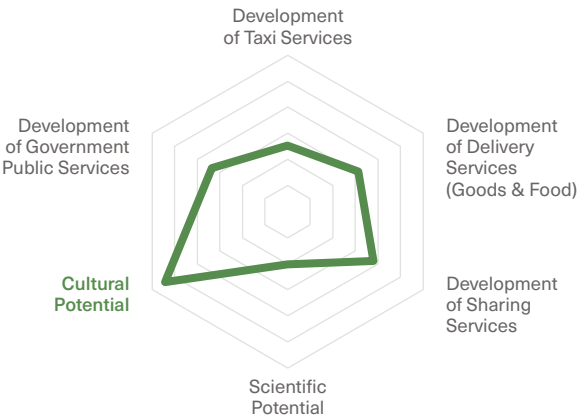
Note: May not sum to total due to rounding

Figure 21.
Cultural Potential

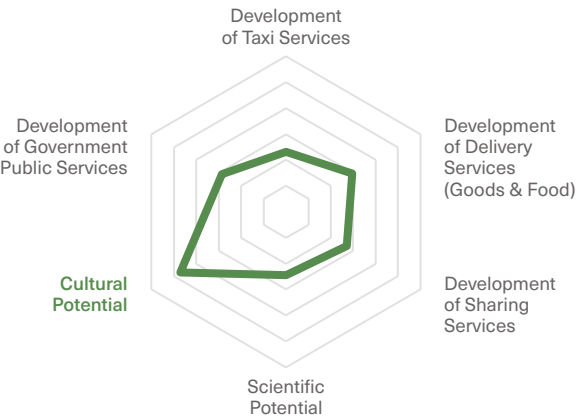


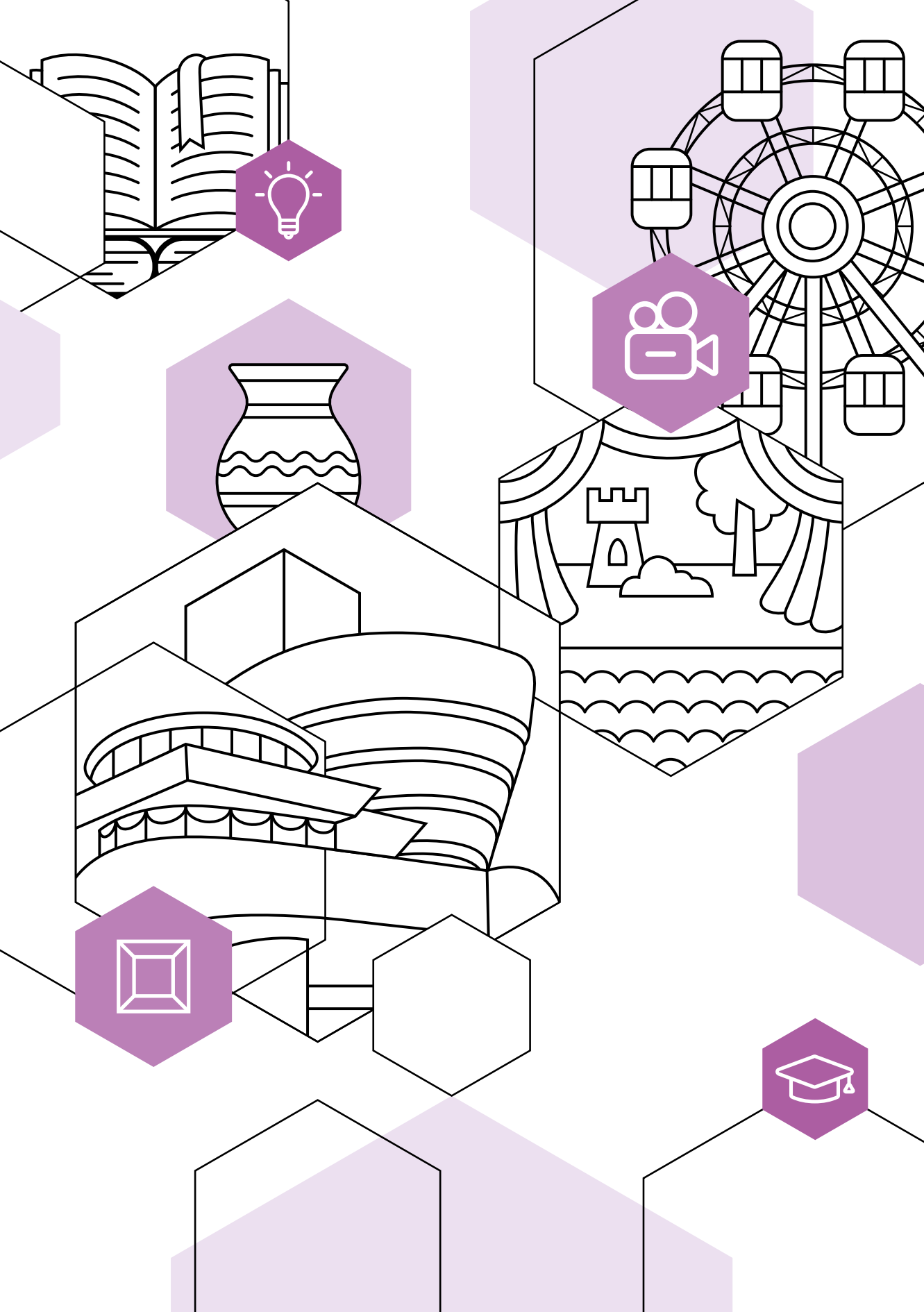
The level of cultural potential also varies greatly. The European capitals — Paris and Berlin — are the leaders. At the same time, they are characterized by a lower level of development of digital services.

Berlin



Paris

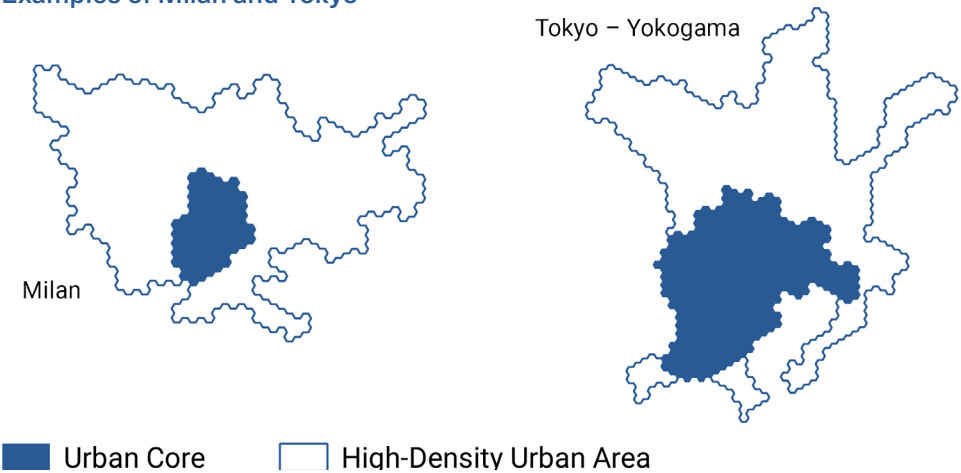




— INDICATOR 6

Innovation Support:
Development
of Government
Public Services

Figure 22:
Determination of Urban Boundaries:
Examples of Milan and Tokyo



Results Overview

The innovative development is connected to public services accessibility and the development of Internet communications in the country. Digitalization of online services saves citizens' time while getting the government public services, and enhances the digital literacy and competencies of the population. It indirectly indicates the digital skills and competencies of residents, the transparency and efficiency of government bodies. Internet accessibility might pose a challenge to the development of public services. For example, due to the digital divide, the lack of access to the Internet affects the possibility for the second wave of digital transformation.

The indicator of accessibility of public services and Internet connection is the highest among the indicators. In contrast to others, it has no clear front-runners: nine cities have high scores above 0,60. This result can be explained by the distinctive nature of the data included. It was collected through an international survey, measuring the perception of residents of the availability of governmental, online and telecommunication services in their country.

Seoul-Incheon and Dubai lead the ranking. Seoul has the highest rate of online services provision among all the countries (consisting of the institutional framework, service and content provision, technology, e-participation), and Dubai — telecommunication infrastructure (including mobile-cellular subscriptions, rate of Internet users, fixed broadband subscriptions, active mobile-broadband subscriptions).

Nearby in the rank are Sydney, Sao Paulo, Beijing, Shanghai, Los Angeles, New York, Riyadh.

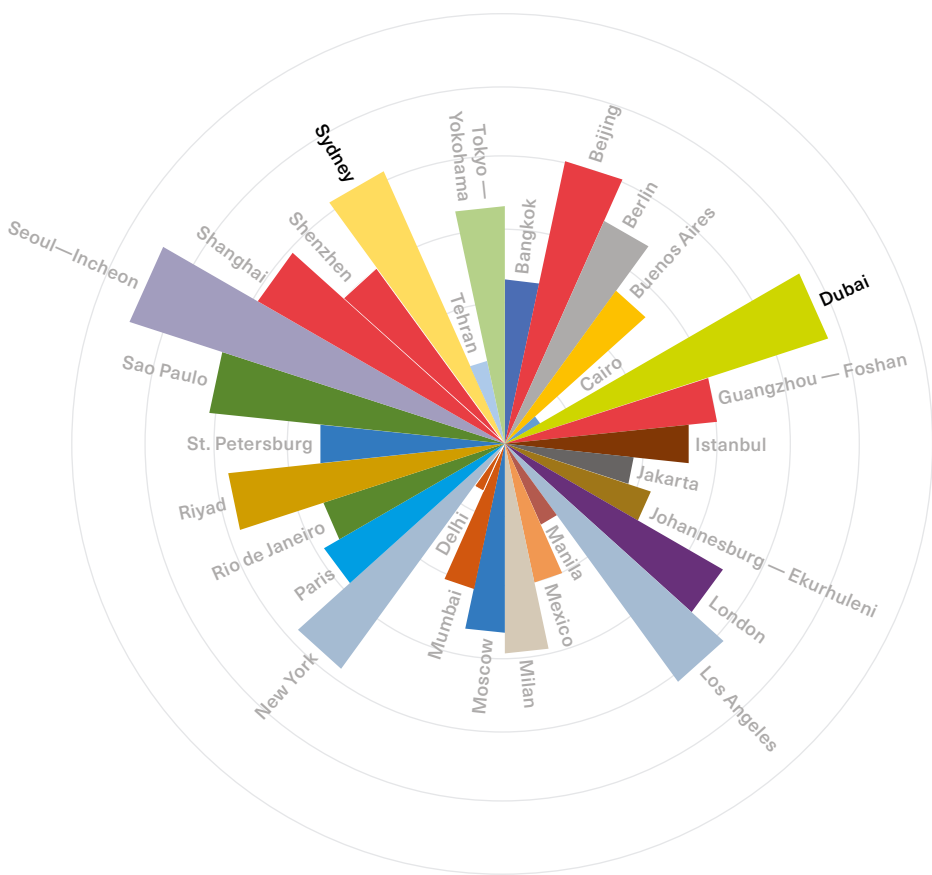
Figure 23.

Innovation Support: Development of Government Public Services

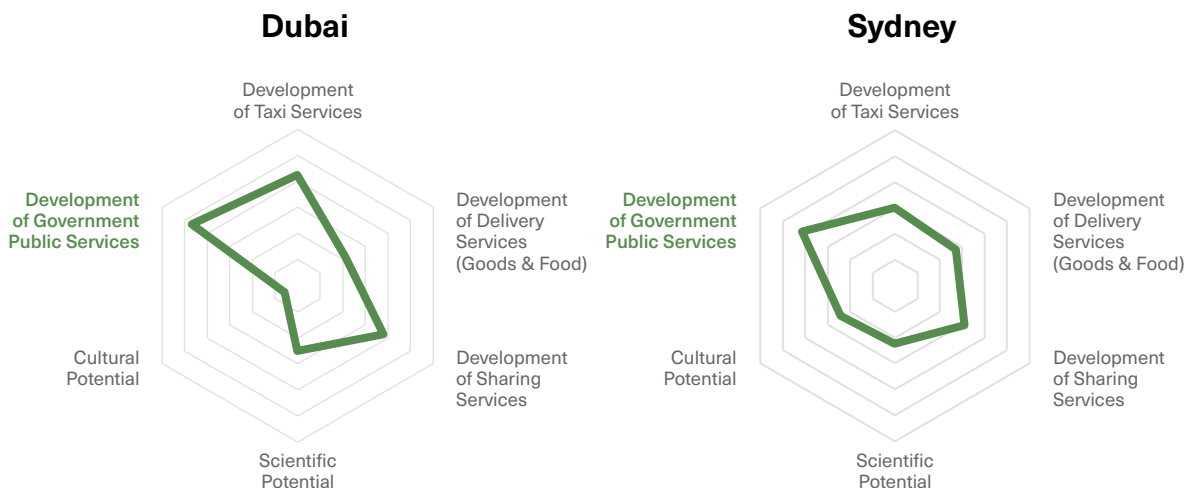
Rank	Agglomeration	Indicator's Score
1	Seoul — Incheon	0,85
2	Dubai	0,74
3	Sydney	0,66
4	Sao Paulo	0,66
5	Los Angeles	0,65
6	Beijing	0,64
7	Shanghai	0,64
8	New York	0,62
9	Riyad	0,62
10	London	0,57
11	Berlin	0,56
12	Tokyo — Yokohama	0,54
13	Shenzhen	0,50
14	Guangzhou — Foshan	0,50
15	Milan	0,49
16	Paris	0,49
17	Rio de Janeiro	0,45
18	Buenos Aires	0,45
19	Moscow	0,45
20	St. Petersburg	0,44
21	Istanbul	0,44
22	Bangkok	0,40
23	Johannesburg — Ekurhuleni	0,38
24	Mumbai	0,37
25	Mexico	0,35
26	Jakarta	0,33
27	Manila	0,25
28	Tehran	0,24
29	Delhi	0,18
30	Cairo	0,16

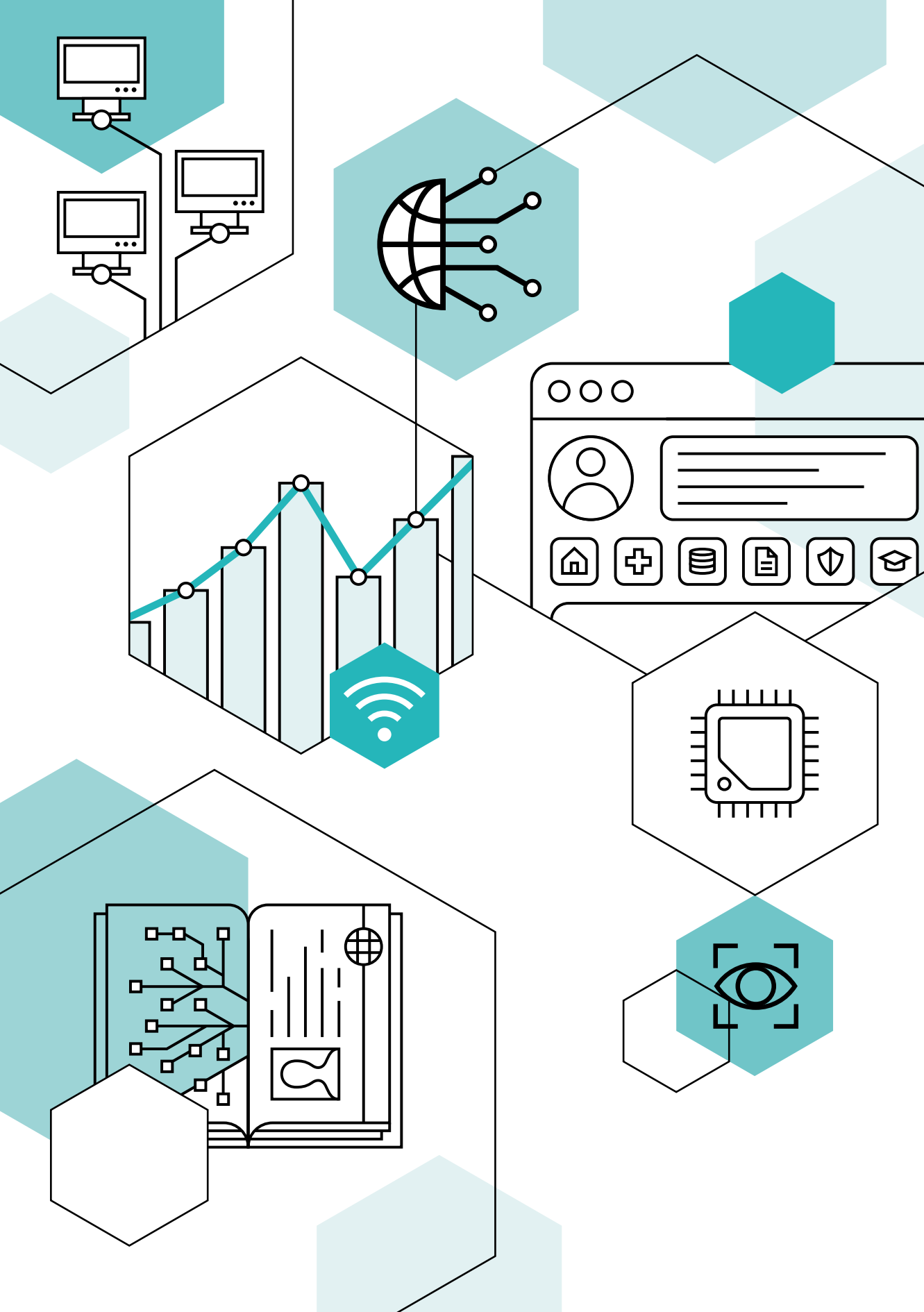
Note: May not sum to total due to rounding

Figure 24.
Innovation Support: Development of Government Public Services



The level of development of government public services in general is quite high. At the same time, the correlation between the value of this indicator and other indicators of the Theretical Framework 1 is quite low.





IV

Physical Accessibility & Diversity of the Urban Environment

Figure 25:
Determination of Urban Boundaries:
Examples of Johannesburg and Seoul

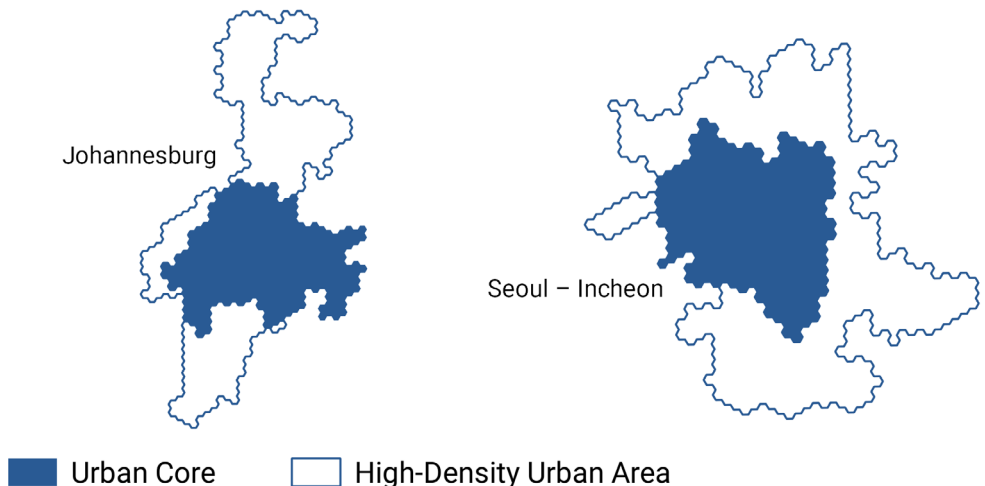


Figure 26.

Ranked list of agglomerations according to the Theoretical Framework 2

Rank	Agglomeration	Set's of Indicators Score
1	Moscow	4,98
2	St. Petersburg	4,86
3	Berlin	4,77
4	Seoul — Incheon	4,71
5	Paris	4,68
6	London	4,57
7	Mumbai	3,97
8	Milan	3,94
9	Shanghai	3,88
10	New York	3,84
11	Beijing	3,81
12	Guangzhou — Foshan	3,71
13	Tokyo — Yokohama	3,64
14	Buenos Aires	3,55
15	Los Angeles	3,39
16	Delhi	3,33
17	Shenzhen	3,26
18	Sao Paulo	3,23
19	Manila	3,22
20	Sydney	3,10
21	Tehran	3,08
22	Istanbul	2,96
23	Bangkok	2,83
24	Rio de Janeiro	2,81
25	Johannesburg — Ekurhuleni	2,81
26	Mexico	2,79
27	Jakarta	2,68
28	Riyad	2,67
29	Dubai	1,90
30	Cairo	1,90

Figure 27.
Profiles of Leading Agglomerations

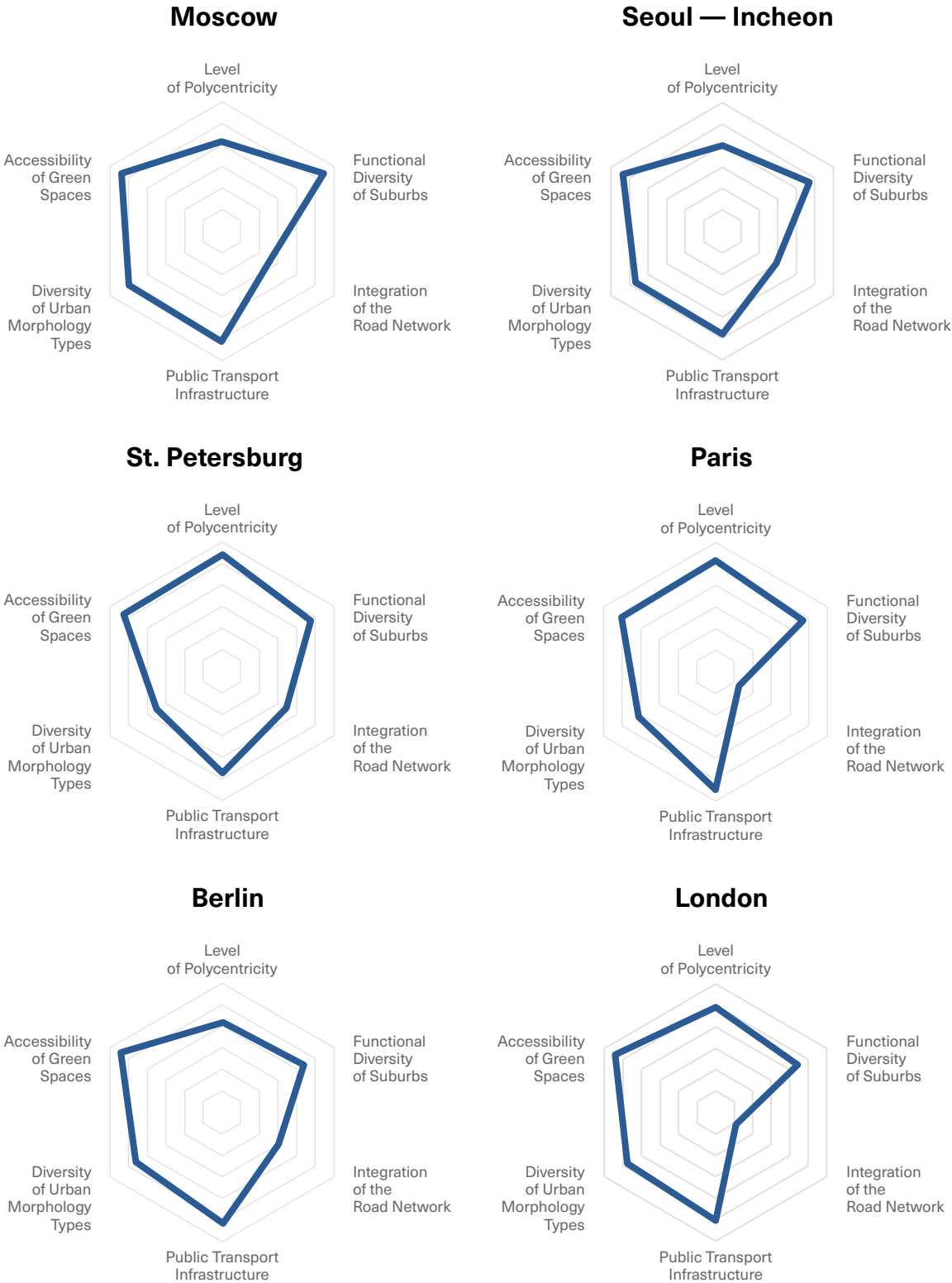
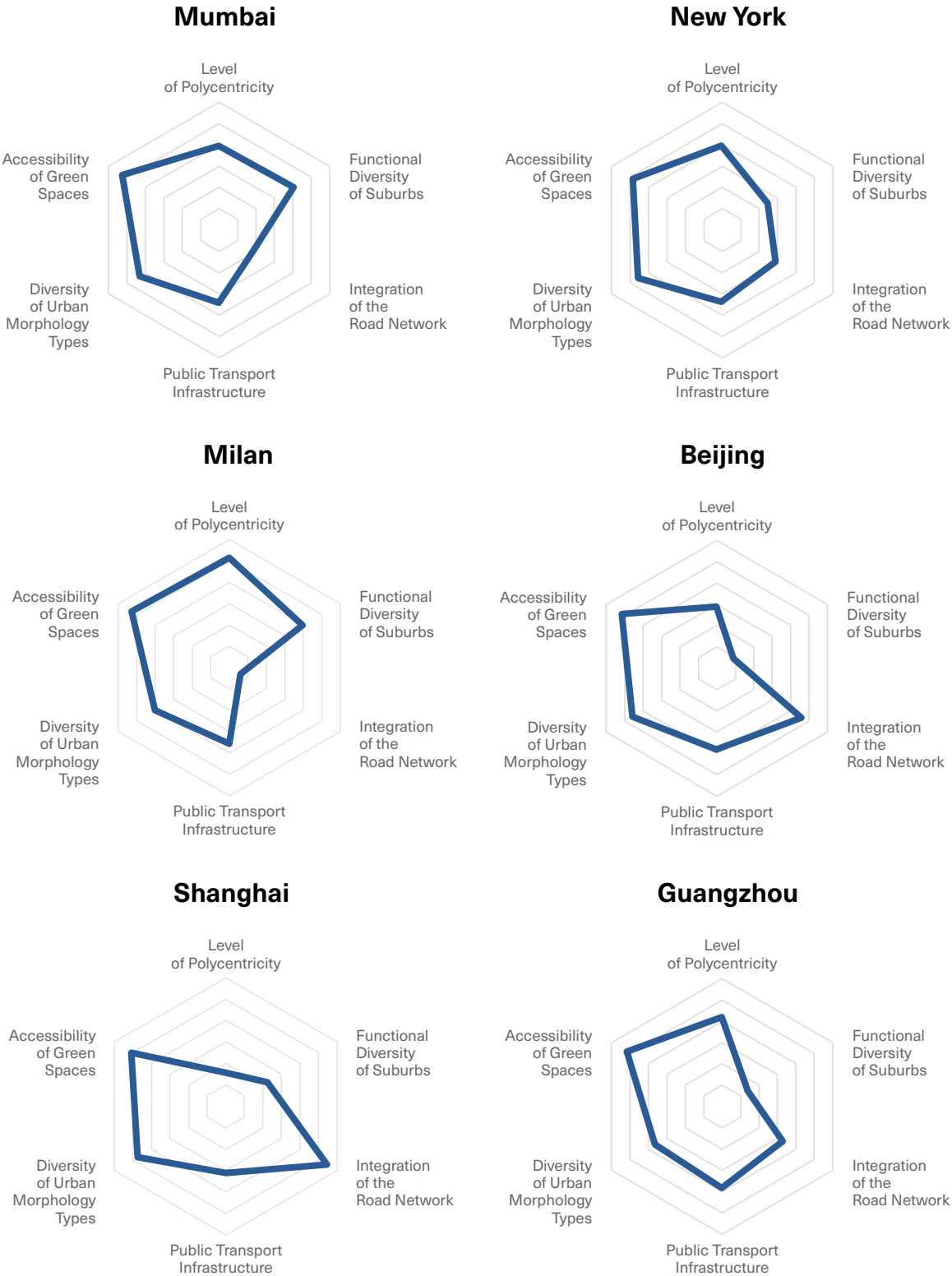


Figure 27 (in continuation).
Profiles of Leading Agglomerations

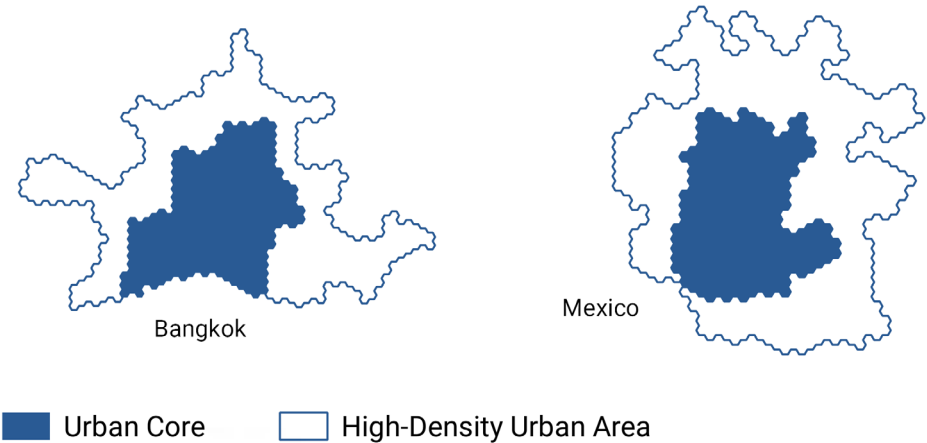


Group of Indicators 1
Balance of Spatial Development

— INDICATOR 1

Level
of Polycentricity

Figure 28:
Determination of Urban Boundaries:
Examples of Bangkok and Mexico



Results Overview

Polycentricity means there is a clear structure of urban nuclei of different sizes and functional content in a city. The urban nucleus is a location that generates sustainable human and financial flows through the concentration of trade, services, recreation, and culture. The concentration of flows and the agglomeration effect from the proximity of businesses becomes a magnet for the location of new services. This is why we can say that large urban nuclei are self-sustaining. They usually have higher transportation accessibility, and the surrounding areas serve a lot of functions, all within easy walking distance, hence a better environment. Consequently, citizens minimize transport costs when moving to various services.

Typical urban nuclei develop through everyday services (grocery stores and cafes) and individual regular (for example, cinemas) and unique (for example, theaters) service facilities. Functions that are in high demand with locals come together to generate an urban nucleus that both provides environmental diversity and is within easy walking distance.

Urban polycentricity means that the spatial development of an agglomeration is balanced and comfortable, and a larger number of residents can quickly and easily reach places where urban activity is concentrated and use their services, resources, and opportunities, saving time, enjoying a higher quality of life, and reducing the load on transport infrastructure.

Let us consider the differentiation of the development of polycentricity in the selected urban agglomerations. There are 13 cities in the group with the largest share of the population living near urban nuclei in the urban core. Most of them are European (St. Petersburg, Paris, Milan, London, Moscow, Berlin), and some are Asian (Tehran, Guangzhou, Seoul, Mumbai, Riyadh, Manila), and only one is American (New York). More than 60% of the population in these cities lives closer than 15 minutes from urban nuclei. It is not surprising that all the European cities studied were in the group of leaders, largely due to the historical development of their spatial structure and generally balanced spatial development.

The average-performing group includes 13 agglomerations from different parts of the world: Asia (Tokyo, Delhi, Beijing, Dubai, Istanbul, Jakarta), America (Buenos Aires, Los Angeles, Rio de Janeiro, Mexico City, São Paulo), Africa (Cairo), Australia (Sydney). These cities have enough urban nuclei, so we can consider them polycentric, albeit somewhat unbalanced within the spatial structure of the agglomeration; this is why the general public does not have enough urban benefits available.

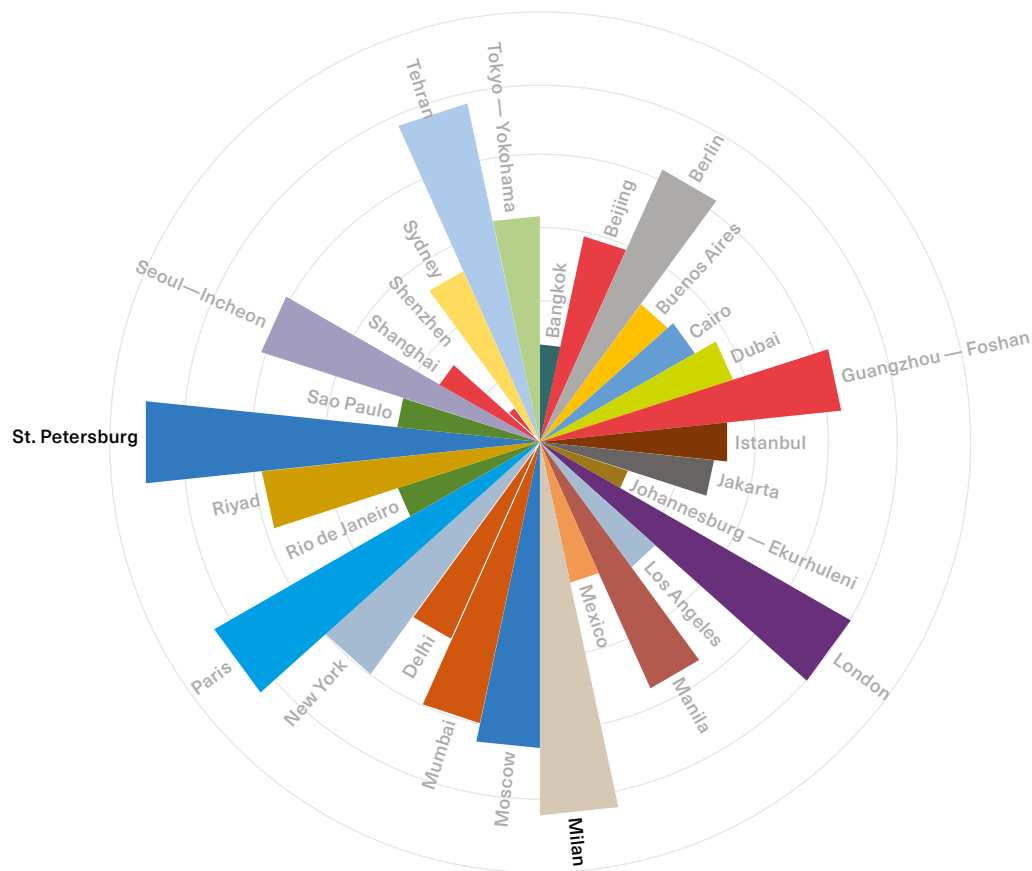
Figure 29.
Level of Polycentricity

Rank	Agglomeration	Indicator's Score
1	St. Petersburg	1,00
2	Paris	0,94
3	Milan	0,94
4	London	0,89
5	Tehran	0,87
6	Moscow	0,75
7	Guangzhou — Foshan	0,74
8	Berlin	0,73
9	Seoul — Incheon	0,71
10	Mumbai	0,70
11	New York	0,70
12	Riyad	0,67
13	Manila	0,65
14	Tokyo — Yokohama	0,53
15	Delhi	0,50
16	Beijing	0,48
17	Dubai	0,46
18	Sydney	0,42
19	Istanbul	0,42
20	Cairo	0,39
21	Jakarta	0,38
22	Buenos Aires	0,37
23	Los Angeles	0,32
24	Rio de Janeiro	0,31
25	Mexico	0,29
26	Sao Paulo	0,29
27	Shanghai	0,21
28	Bangkok	0,16
29	Johannesburg — Ekurhuleni	0,15
30	Shenzhen	0,01

Note: May not sum to total due to rounding

Note: Due to the single variable the maximum normalized value does not mean the maximum possible value

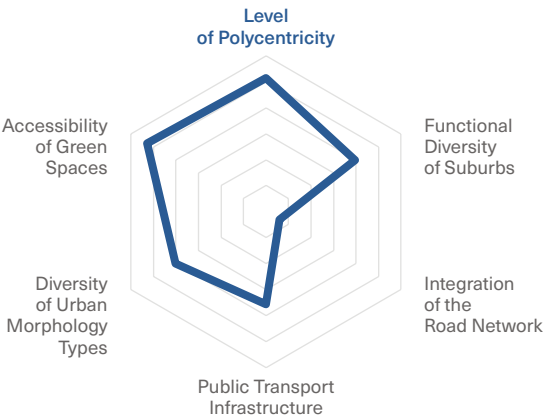
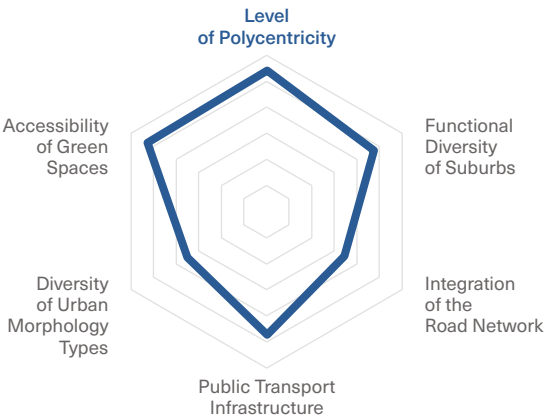
Figure 30.
Level of Polycentricity



Polycentricity as a complex indicator is usually accompanied by a general balance of spatial development. The good development of the transport system and the high diversity of the environment are characteristic of leading polycentric agglomerations.

St. Petersburg

Milan



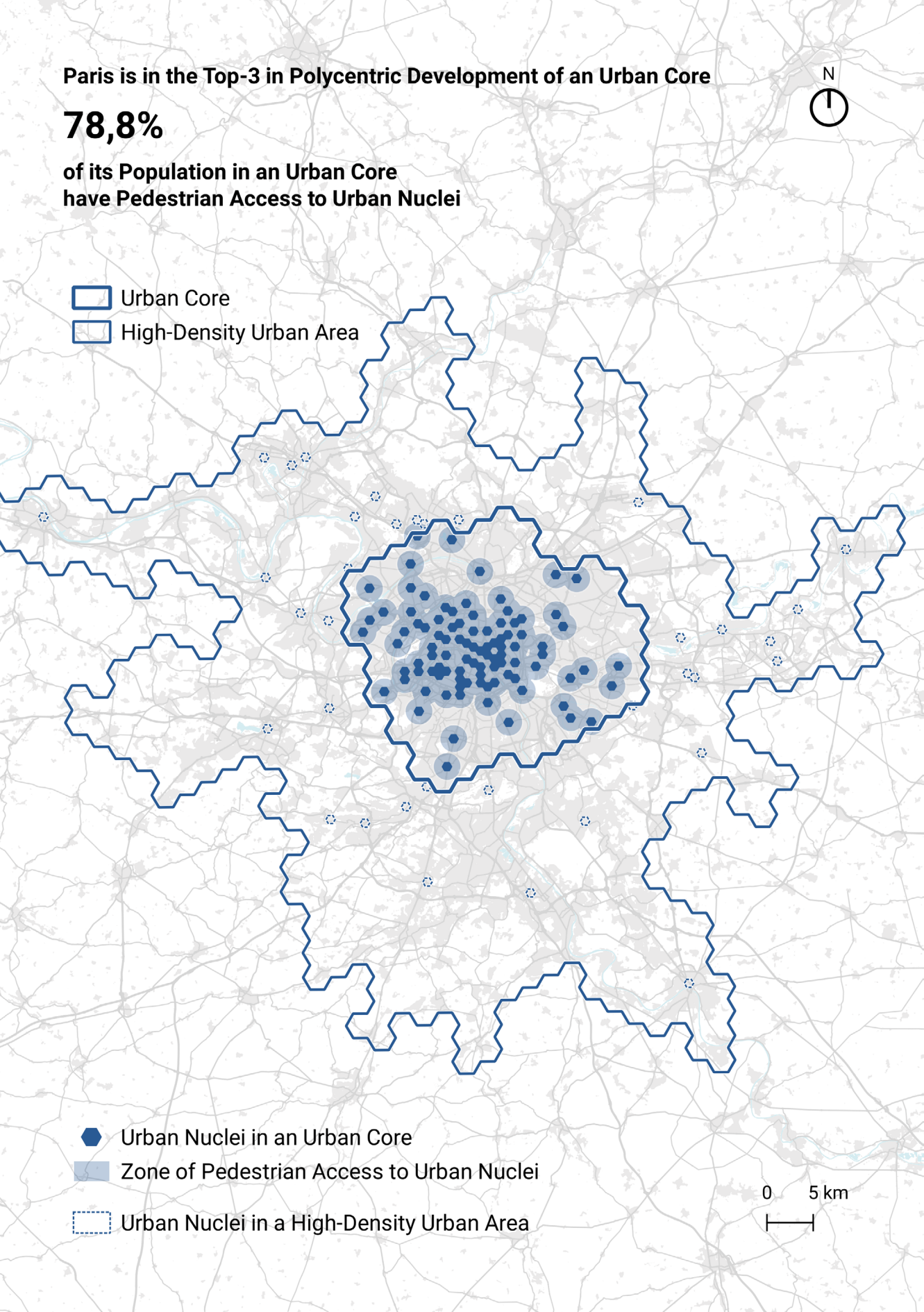
Paris is in the Top-3 in Polycentric Development of an Urban Core

78,8%

of its Population in an Urban Core
have Pedestrian Access to Urban Nuclei



- Urban Core
- High-Density Urban Area



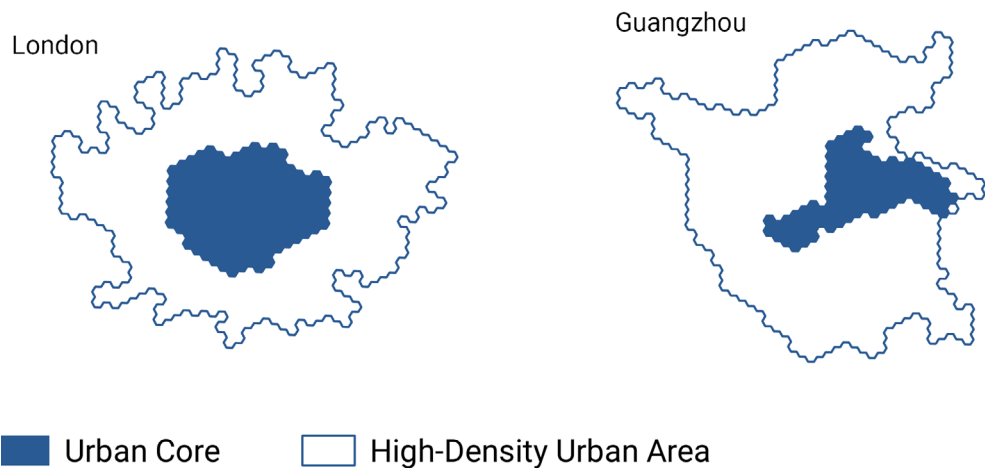
- Urban Nuclei in an Urban Core
- Zone of Pedestrian Access to Urban Nuclei
- Urban Nuclei in a High-Density Urban Area

0 5 km

Group of Indicators 1
Balance of Spatial Development

— INDICATOR 2
Functional Diversity
of Suburbs

Figure 31:
Determination of Urban Boundaries:
Examples of London and Guangzhou



Results Overview

Polycentric models helped us assess both the polycentricity of urban cores and the functional diversity of suburbs. There is an issue, however, with insufficient proximity to urban amenities in the suburbs. Modern urban research has been addressing the phenomenon of urban sprawl, i.e., the expansion of suburbs with insufficient access to functions. Such sprawl overloads public transport infrastructure, decreases the value of real estate, and can marginalizes certain areas in extreme cases. Another consequence is a decrease in the availability of services on the periphery of the urban core due to increased demand from residents of the suburban area.

It is challenging for new urban nuclei to develop, as low-density housing and low urban intensity decrease the concentration of flows and the profitability of some functions. This is why we prepared a separate simulation of the polycentric structure of the high-density urban area.

We used the following assumption to assess the quality of life in a suburban area: a resident of a suburban area can significantly save time if there are major concentrations of functions within easy walking distance. Otherwise, they will be forced to travel to the urban core to satisfy everyday needs (for example, to buy groceries or meet with friends) or use delivery at higher financial costs.

The first group included cities with the largest share of the population living within a 15-minute walk from urban centers and with the lowest urban sprawl. These are European cities (Moscow, St. Petersburg, Paris, London, Berlin), cities in Asia (Tehran, Seoul), and South American São Paulo. This is largely due to the development of the spatial structure, where large centers and places of concentration of urban functions are located in the suburbs, and the suburban area is made up of satellite cities supporting the surrounding areas and mirroring the functions of the main core of the agglomeration.

The average-performing group includes agglomerations from all over the world, where centers of urban activity, although available in the suburbs, are distributed unevenly, and the majority of the population does not have significant concentrations of services within easy walking distance, so citizens may have a harder and longer time accessing city amenities.

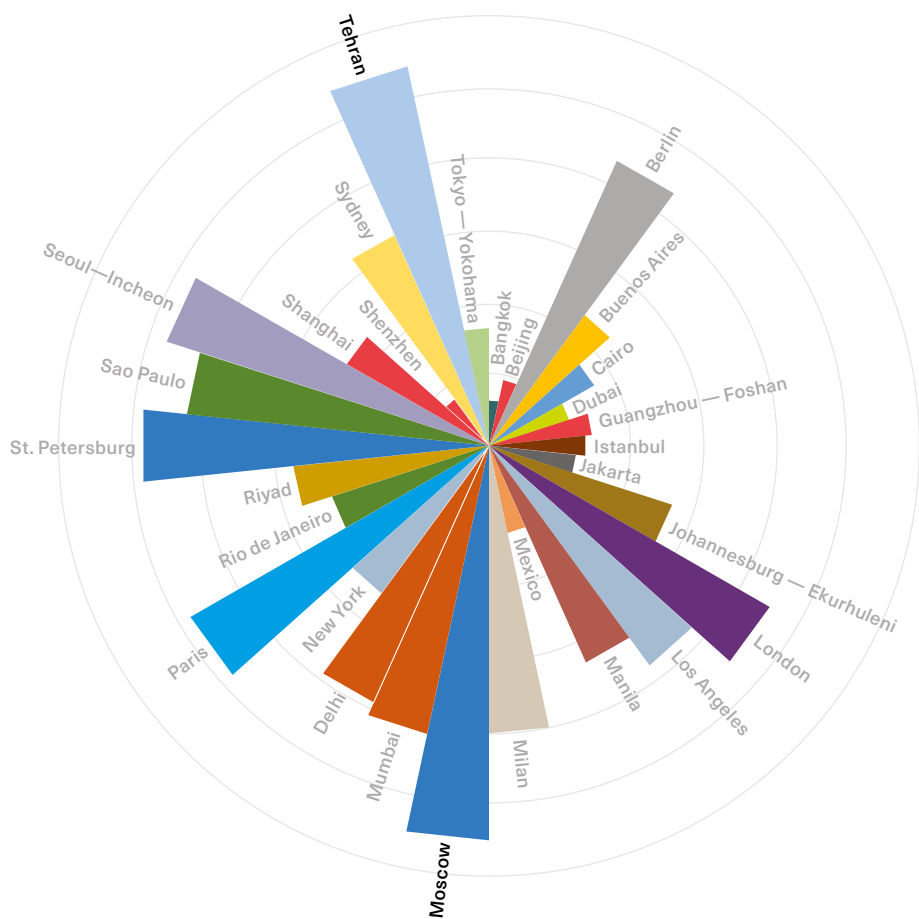
Figure 32.
Functional Diversity of Suburbs

Rank	Agglomeration	Indicator's Score
1	Moscow	1,00
2	Tehran	0,98
3	St. Petersburg	0,86
4	Paris	0,85
5	Seoul — Incheon	0,84
6	London	0,80
7	Berlin	0,77
8	Sao Paulo	0,74
9	Mumbai	0,72
10	Milan	0,70
11	Delhi	0,69
12	Los Angeles	0,66
13	Manila	0,56
14	Sydney	0,54
15	Riyad	0,44
16	Johannesburg — Ekurhuleni	0,43
17	New York	0,41
18	Rio de Janeiro	0,36
19	Shanghai	0,35
20	Buenos Aires	0,35
21	Cairo	0,24
22	Tokyo — Yokohama	0,23
23	Guangzhou — Foshan	0,18
24	Istanbul	0,17
25	Mexico	0,15
26	Jakarta	0,14
27	Dubai	0,13
28	Beijing	0,09
29	Shenzhen	0,06
30	Bangkok	0,02

Note: May not sum to total due to rounding

Note: Due to the single variable the maximum normalized value does not mean the maximum possible value

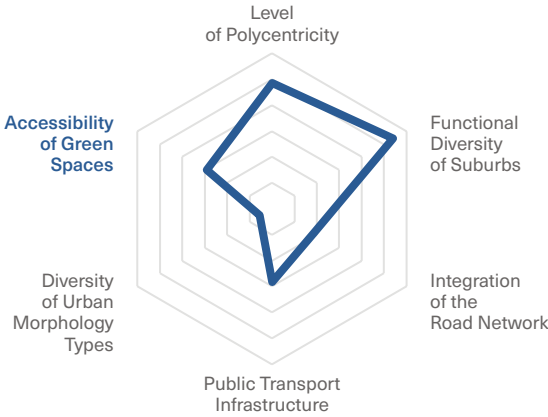
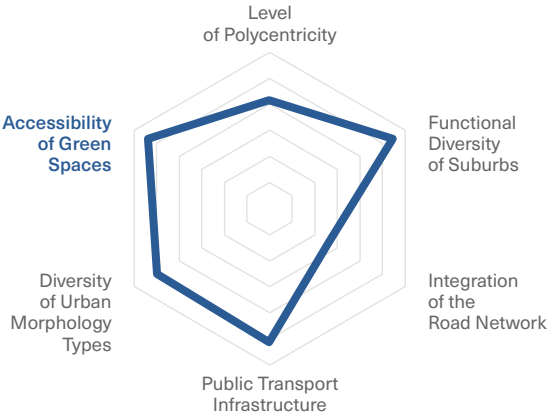
Figure 33.
Functional Diversity of Suburbs



High-Density Urban Area is characterized by low functional diversity. There are exceptions, but their reasons may be different. For European cities this is a consequence of urban planning policy

Moscow

Tehran

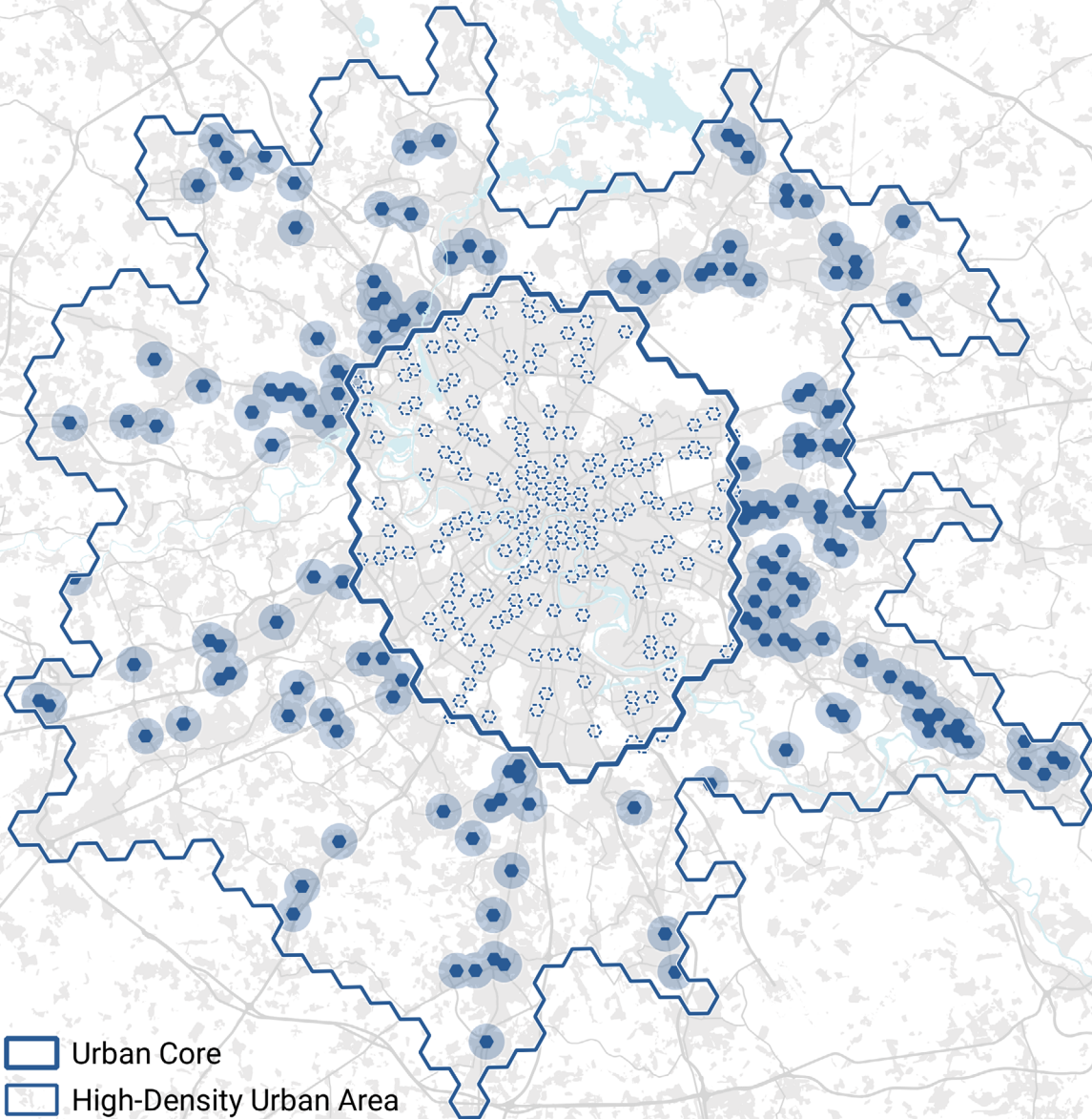


Moscow is in the List of Leaders in Polycentric Development

38,4%

of its Population in a High-Density Urban Area
have Pedestrian Access to Urban Nuclei

67,6% – the Value of the Indicator in an Urban Core



- Urban Core
- High-Density Urban Area
- Urban Nuclei in a High-Density Urban Area
- Zone of Pedestrian Access to Urban Nuclei
- Urban Nuclei inside an Urban Core

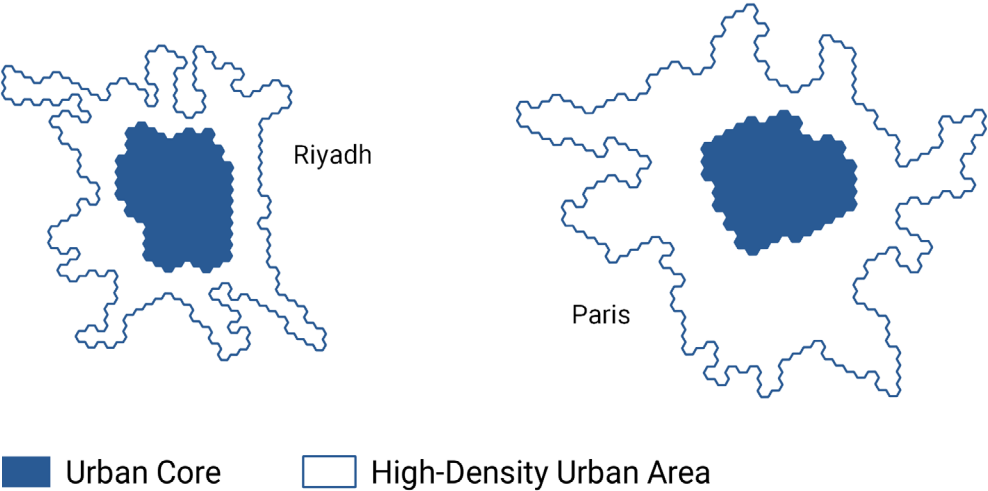
0 5 km

Group 2:
Transport Accessibility

— INDICATOR 3:

Integration
of the Road Network

Figure 34:
Determination of Urban Boundaries:
Examples of Riyadh and Paris



Results Overview

The road network is the pillar of urban mobility. The configuration of the road network ensures both active and passive accessibility within the area. The connectivity of the network enables citizens to move around, order deliveries and taxi services, and engage in ride-sharing. High network integration can mean more route options and less congestions on some segments of the road network. However, there is a drawback: high route diversity can lower flow concentration for short distances and walking simulations, which may discourage the establishment of new service facilities due to their sensitivity to visitor flow density.

The assessment of the road network configuration is based on the median value of the integration index within the boundaries of a high-density urban area and urban core. We calculate the index according to the Space Syntax methodological approach. A higher value of the variable means greater integration of key segments of the urban network in the city and greater potential for pedestrian and micromobility connections in the city.

There are ten agglomerations in the group of leaders: Shanghai, Beijing, Los Angeles, Riyadh, Shenzhen, Johannesburg, Bangkok, St. Petersburg, Guangzhou. These cities typically have a regular planning structure and a maximum density of road network segments; there are no largely isolated segments in the suburban area or significant physical and geographical barriers, such as mountain ranges, rivers, and bays. Shenzhen and St. Petersburg are exceptions; however, multiple tunnels and bridges compensate for the challenging terrain or hydrographic situation, ensuring a well-integrated network.

The average-performing group includes eight agglomerations: Berlin, New York, Seoul, New Delhi, Tokyo, Mexico City, Moscow, and Sydney. These cities feature more prominent barriers of different types, including physical and geographical, anthropogenic (like belt of industrial zones), etc. Uneven planning structure, curvature of routes (in particular, in historical parts) can lower the indicator, keeping network integration in the middle of the ranking.

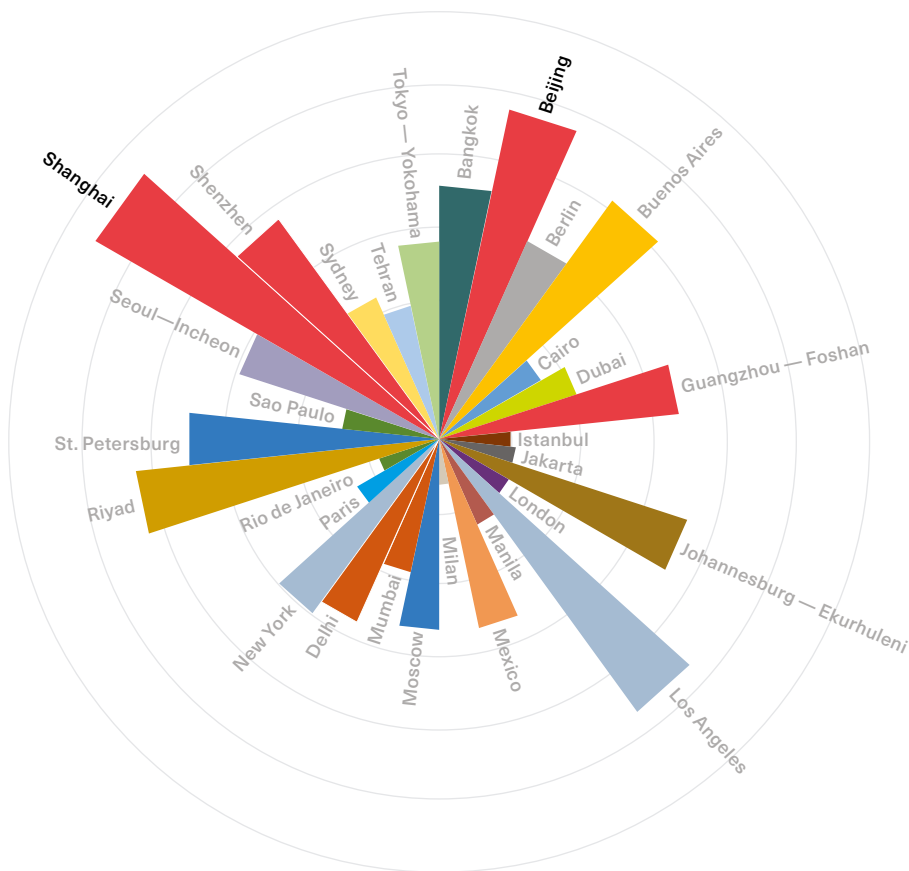
Figure 35.
Integration of the Road Network

Rank	Agglomeration	Indicator's Score
1	Shanghai	1,00
2	Beijing	0,83
3	Los Angeles	0,83
4	Riyad	0,74
5	Buenos Aires	0,71
6	Shenzhen	0,65
7	Johannesburg — Ekurhuleni	0,62
8	Bangkok	0,60
9	St. Petersburg	0,59
10	Guangzhou — Foshan	0,56
11	Berlin	0,49
12	New York	0,49
13	Seoul — Incheon	0,47
14	Delhi	0,45
15	Tokyo — Yokohama	0,44
16	Mexico	0,42
17	Moscow	0,40
18	Sydney	0,32
19	Dubai	0,29
20	Tehran	0,27
21	Mumbai	0,26
22	Cairo	0,21
23	Paris	0,19
24	Sao Paulo	0,15
25	Manila	0,14
26	London	0,11
27	Jakarta	0,10
28	Istanbul	0,08
29	Rio de Janeiro	0,06
30	Milan	0,01

Note: May not sum to total due to rounding

Note: Due to the single variable the maximum normalized value does not mean the maximum possible value

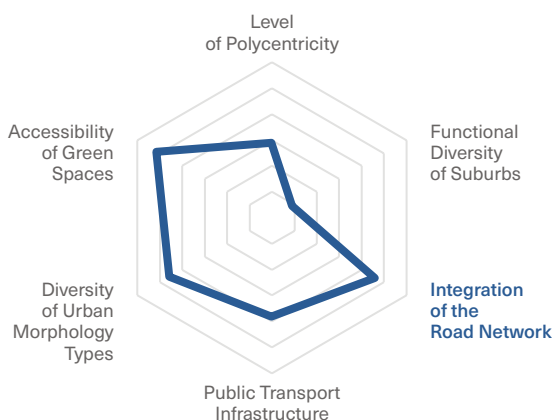
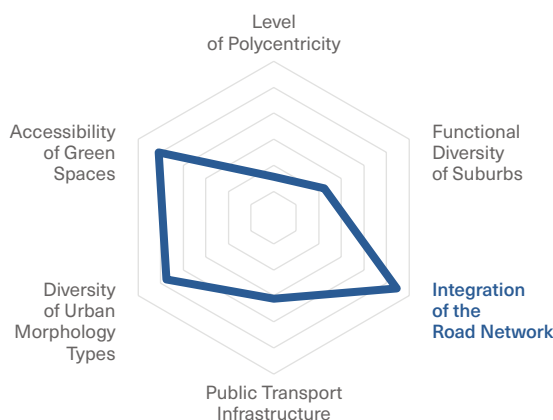
Figure 36.
Integration of the Road Network



The leaders in the Integration of the Road Network - Shanghai, Beijing, Los Angeles, Riyadh — are characterized by a regular planning structure.

Shanghai

Beijing

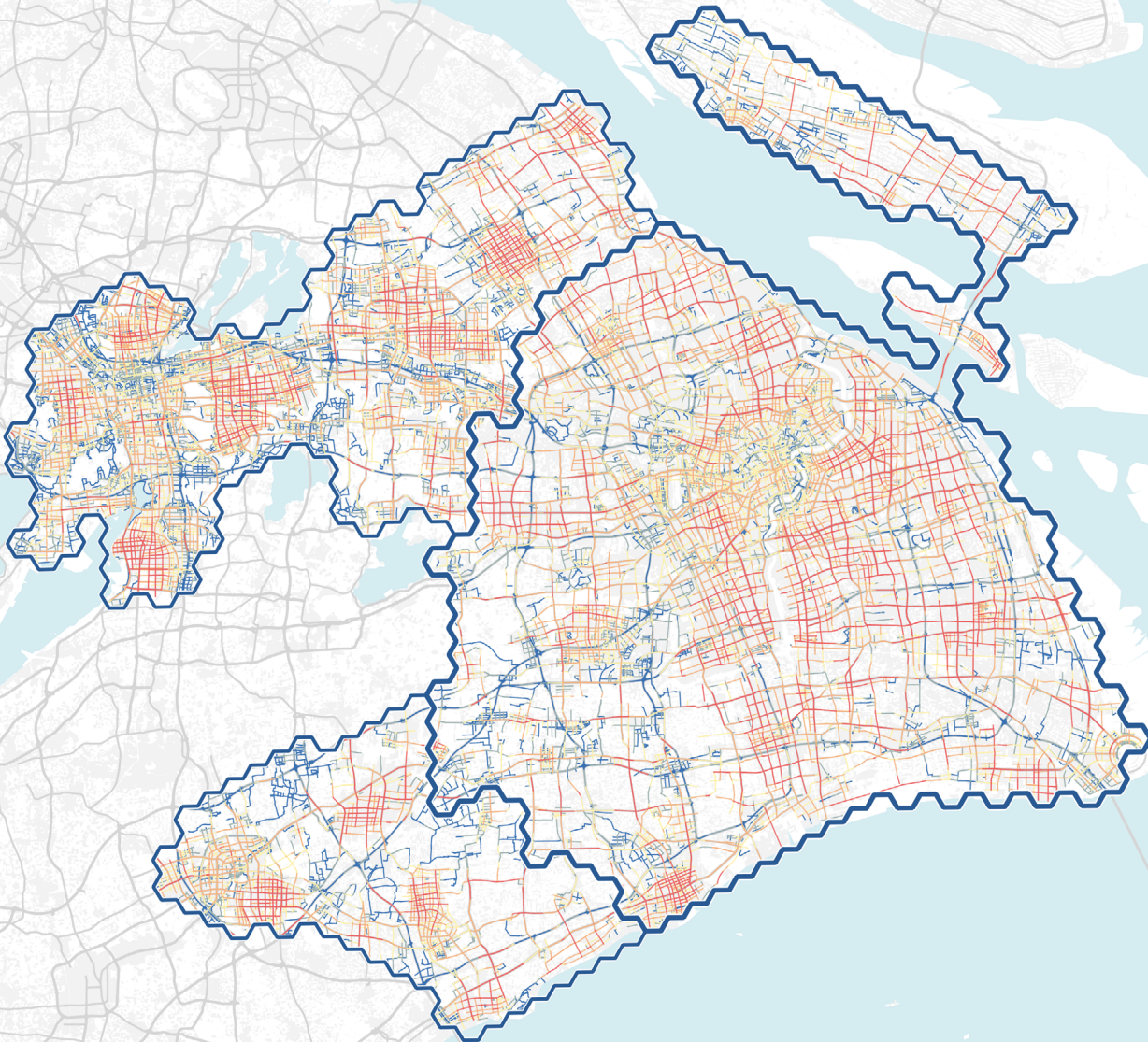


The Integration of the Road Network in Shanghai is the Highest among the Analyzed Agglomerations



The Level of Integration of Road Segments

min | | | | max



0 10 km

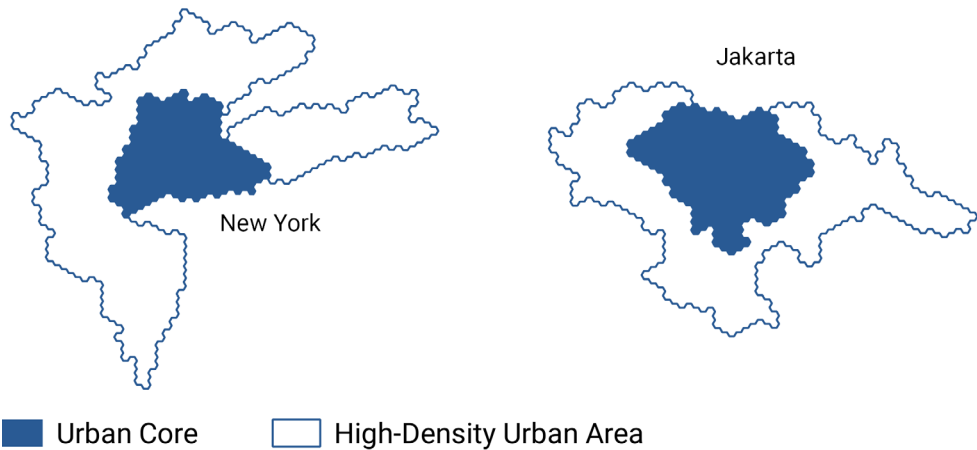
Urban Core
High-Density Urban Area

Group 2:
Transport Accessibility

— INDICATOR 4

Public Transport
Infrastructure

Figure 31:
Determination of Urban Boundaries:
Examples of New York and Jakarta



Results Overview

Public transport is the pillar of a city's mobility system: it reduces travel time between different locations of the city for its residents by providing fast and efficient travel options. The percentage of the population living within easy walking distance of stops indicates the level of development of the public transport infrastructure. We analyze ground and underground (& railway) transportation accessibility separately since they have different roles in the transport system.

We only can include stops and stations in our calculations. Unconventional modes of transport do not have an established route network, so we are not able to analyze them as it would go against the basic methodology of the Index. They are unpredictable and potentially the opposite of time-saving, hindering tourist and visit movement around the city. These local specifics result in a significant variation in the values of the variables; about 5%–93% of the population lives within 500 meters from ground urban passenger transportation stops, and 4%–62% lives within 1000 meters from metro stations and suburban trains.

Paris is the front-runner in the ranking: over 90% of the population has a ground transportation stop within walking distance. In addition to it, the group of leaders included most European agglomerations (Berlin, Moscow, St. Petersburg, London), agglomerations of China, Japan, and Korea (Shenzhen, Guangzhou, Tokyo, Seoul), Australia's Sydney and Brazil's Sao Paulo. The group also has high accessibility values for metro or train stations, but Sao Paulo's underground indicator is quite low, meaning that the main burden falls on ground public transport.

The group with average performance includes 10 agglomerations. There were agglomerations from all over the world: South American (Buenos Aires, Rio de Janeiro), North American (New York and Los Angeles), Asian cities (Istanbul, Tehran, Shanghai, Mumbai, Beijing), and Europe's Milan. These are cities where only about half the population has access to public transport within walking distance, but this can be for a variety of reasons. North American cities have high vehicle ownership rates, making public transport a less popular mode of travel. This also means that the road network is well-organized, and taxi services are widespread.

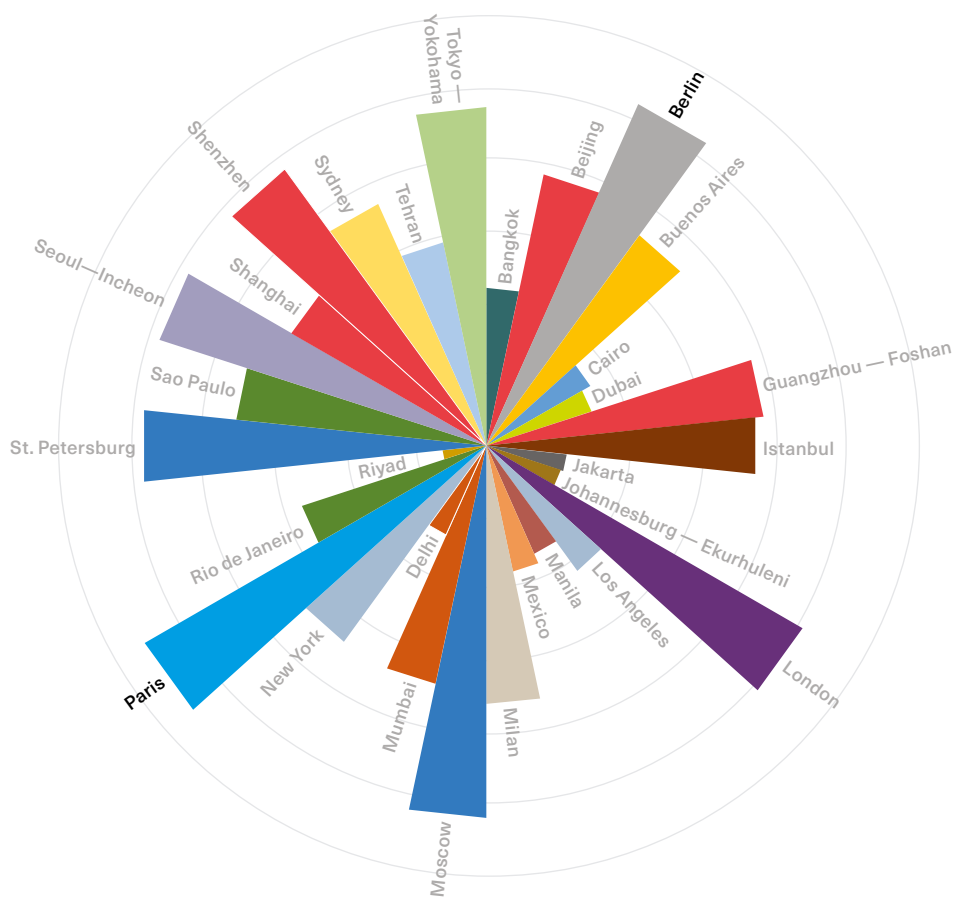
Figure 38.
Public Transport Infrastructure

Rank	Agglomeration	Indicator's Score
1	Paris	1,00
2	Berlin	0,94
3	Moscow	0,94
4	London	0,92
5	St. Petersburg	0,86
6	Seoul — Incheon	0,86
7	Shenzhen	0,86
8	Tokyo — Yokohama	0,84
9	Guangzhou — Foshan	0,68
10	Beijing	0,67
11	Istanbul	0,65
12	Sydney	0,64
13	Buenos Aires	0,63
14	Milan	0,62
15	Sao Paulo	0,60
16	Mumbai	0,58
17	New York	0,58
18	Shanghai	0,53
19	Tehran	0,48
20	Rio de Janeiro	0,44
21	Bangkok	0,34
22	Los Angeles	0,33
23	Mexico	0,26
24	Cairo	0,24
25	Manila	0,23
26	Dubai	0,21
27	Delhi	0,17
28	Jakarta	0,13
29	Johannesburg — Ekurhuleni	0,12
30	Riyad	0,02

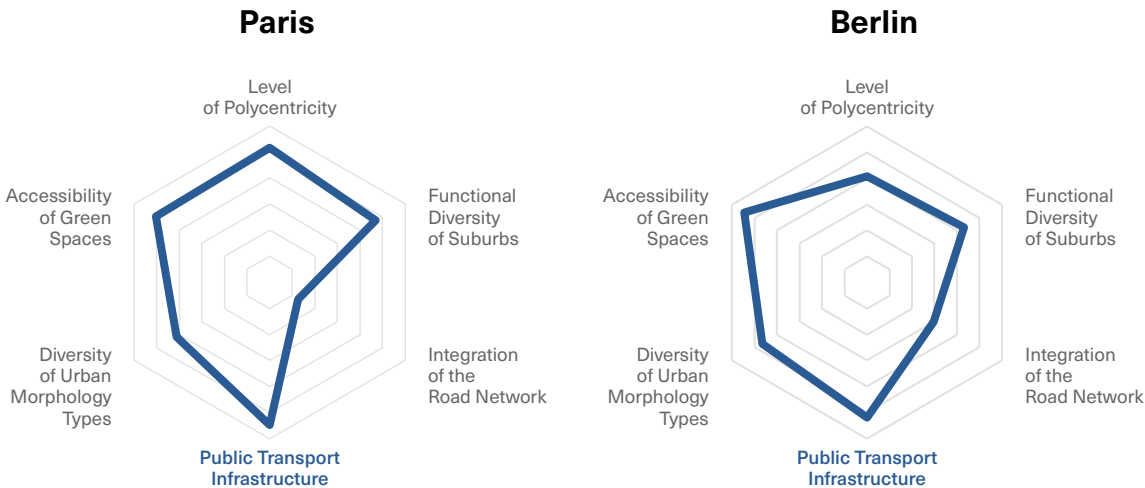
Note: May not sum to total due to rounding

Note: Due to the single variable the maximum normalized value does not mean the maximum possible value

Figure 39.
Public Transport Infrastructure



The leaders in the development of Public Transport Infrastructure are Chinese, European cities, as well as Tokyo, Seoul and Istanbul. For many leaders transport infrastructure is becoming a important factor of balanced spatial development.



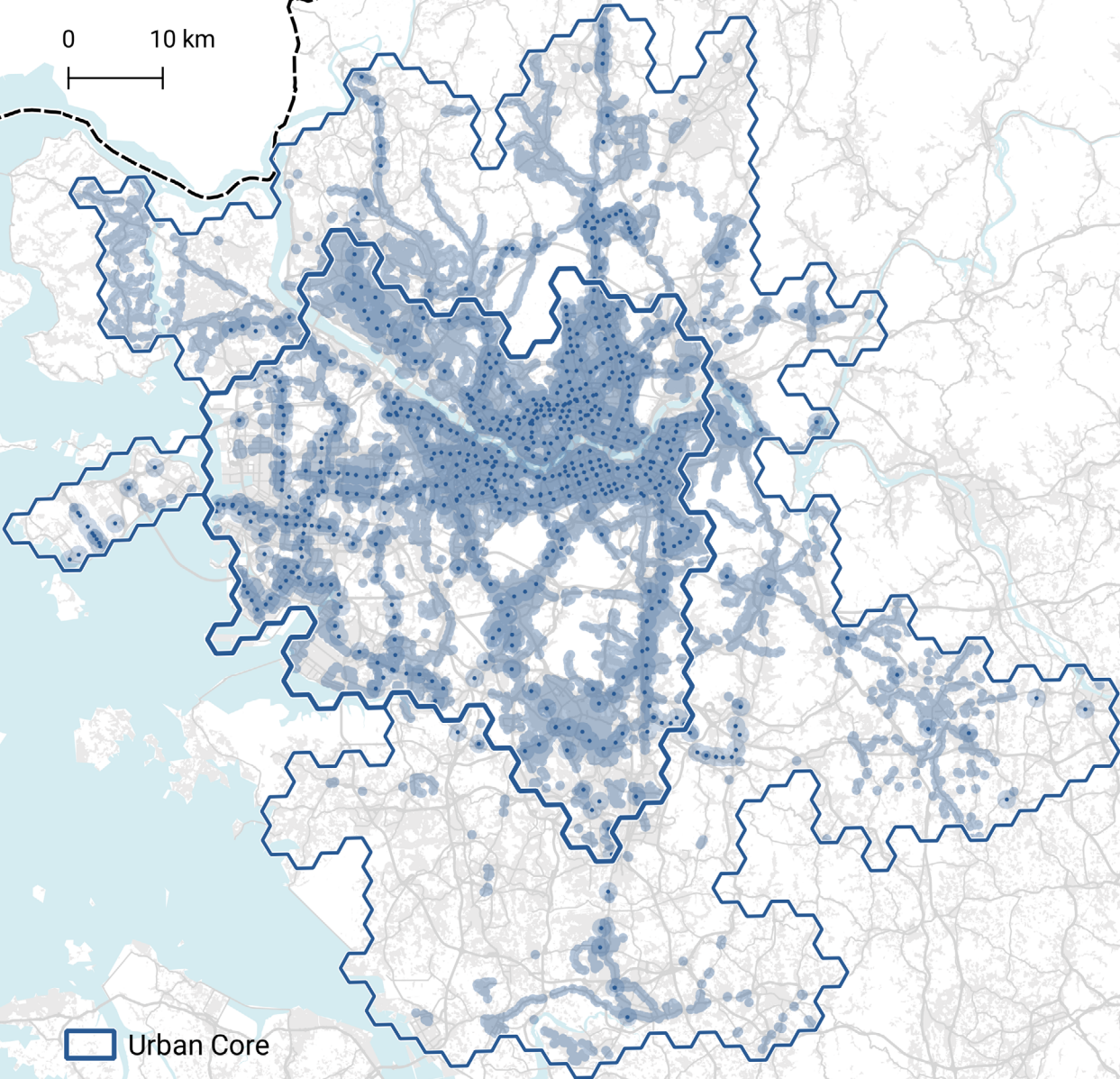
The Agglomeration of Seoul – Incheon is on the List of Leaders in Asia in Terms of Public Transport Development

74,5% & 57,7%

of its Population have Pedestrian Access to Bus Stops & Railway Stations correspondingly



0 10 km



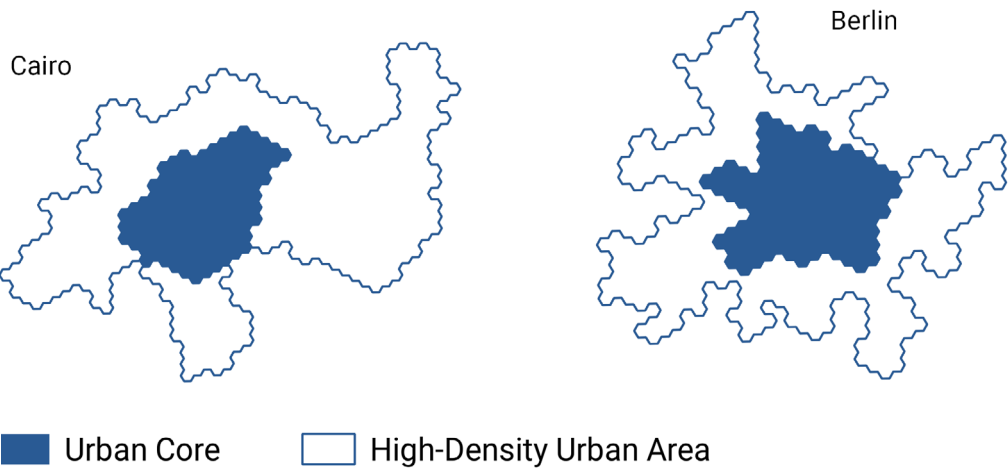
- Urban Core
- High-Density Urban Area
- Railway Stations
- Zone of Pedestrian Access both to Bus Stops & Railway Stations
- Zone of Pedestrian Access to Bus Stops or Railway Stations

Group 3:
Diversity of Built Environment

— INDICATOR 5:

**Diversity of Urban
Morphology Types**

Figure 40:
Determination of Urban Boundaries:
Examples of Cairo and Berlin



Results Overview

The high diversity in urban environments is closely related to the concept of time-saving, as it provides city residents with faster access to areas serving various functional purposes and accommodating regular and irregular activities. The built-up morphology contributes to the environment's diversity: urban blocks planning affects the configuration and openness of areas, business options and flows.

The morphological diversity of cities enables businesses to more easily adapt to changing demand and provide better service to consumers. Diversity also reduces the burden on the transportation system because it makes for shorter commute and ordinary travel. The diversity of urban morphology becomes another crucial aspect of the city's spatial development, promoting its polycentric development.

The indicator includes one derived variable (diversity of building morphology, measured through the Herfindahl-Hirschman index), calculated using two basic variables: GSI and OSR, both calculated in accordance with the Spacemate methodological framework.

The diversity of morphotypes in the agglomerations under consideration is moderate; the median value of the inverted Herfindahl-Hirschman index for the analyzed sample is 0.73. This means that the city features various types of development morphology, different in density, underdeveloped areas, and population count.

The leader group includes cities with highly diverse development morphology: cities from Southeast Asia, Europe, Russia, China, and Mexico. Jakarta is the undisputed winner, with an index value of 0.81 (normalized value – 1.0). It features four equally represented types of building morphology in the high-density urban area.

The average-performing group has moderate diversity in development morphology: Delhi has a maximum index value of 0.75 (normalized value – 0.82), and Shenzhen has a minimum of 0.71 (normalized value – 0.69). Another Chinese city, Beijing, has an index value of 0.75 (normalized value – 0.81). Despite the average basic indicator values, Beijing is a rather diverse city. The same morphotypes may contain functionally diverse environments, including both residential areas and university campuses, areas with architectural sites and tourist attractions, as well as areas that strike the perfect balance between housing, services, and recreation.

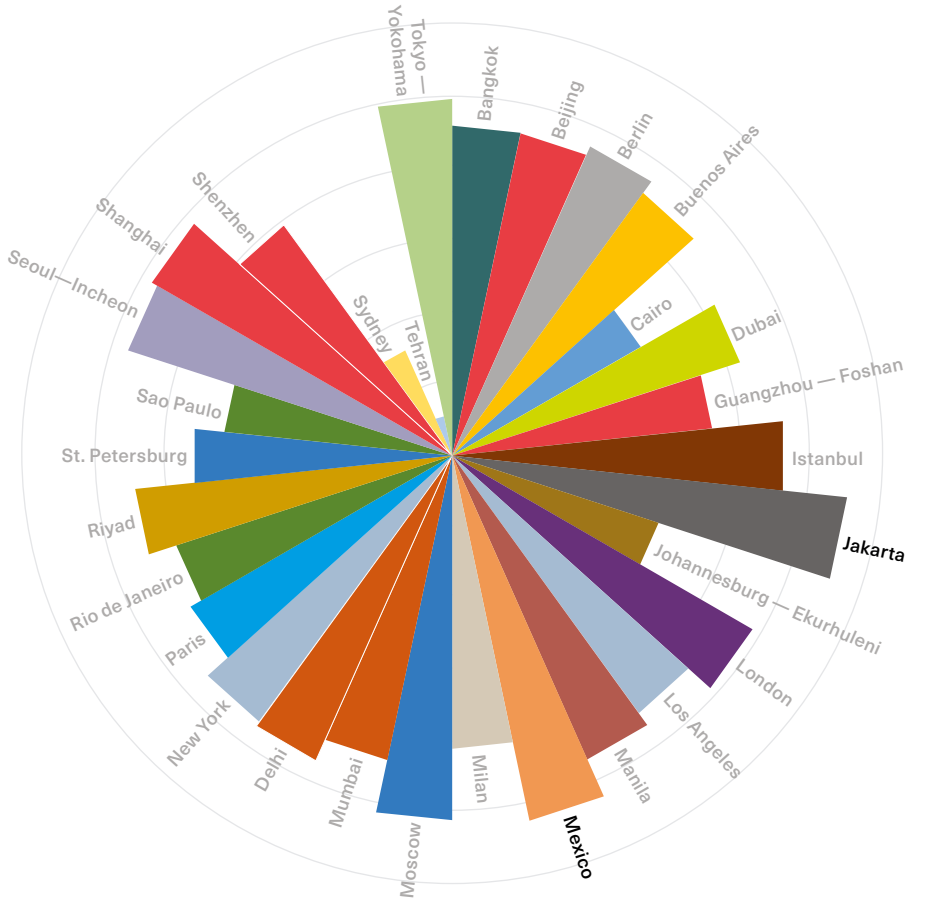
Figure 41.
Diversity of Urban Morphology Types

Rank	Agglomeration	Indicator's Score
1	Jakarta	1,00
2	Mexico	0,93
3	Moscow	0,90
4	Tokyo — Yokohama	0,89
5	London	0,86
6	Shanghai	0,86
7	Seoul — Incheon	0,84
8	Berlin	0,84
9	Delhi	0,82
10	Istanbul	0,82
11	Manila	0,82
12	Bangkok	0,81
13	Beijing	0,81
14	New York	0,81
15	Buenos Aires	0,80
16	Riyad	0,78
17	Los Angeles	0,78
18	Paris	0,77
19	Mumbai	0,76
20	Dubai	0,74
21	Milan	0,71
22	Rio de Janeiro	0,70
23	Shenzhen	0,69
24	Guangzhou — Foshan	0,62
25	St. Petersburg	0,58
26	Sao Paulo	0,53
27	Cairo	0,50
28	Johannesburg — Ekurhuleni	0,50
29	Sydney	0,21
30	Tehran	0,00

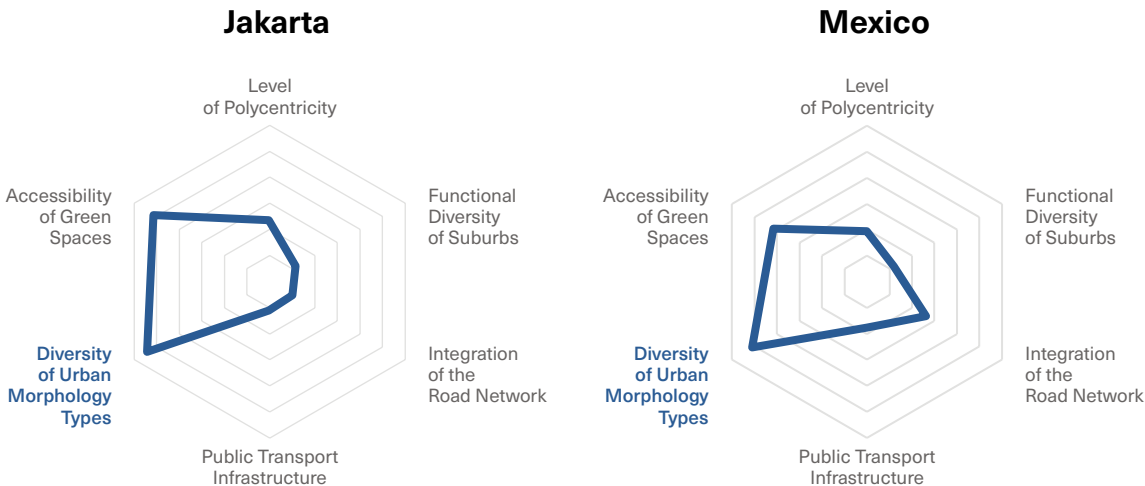
Note: May not sum to total due to rounding

Note: Due to the single variable the maximum normalized value does not mean the maximum possible value

Figure 42.
Diversity of Urban Morphology Types



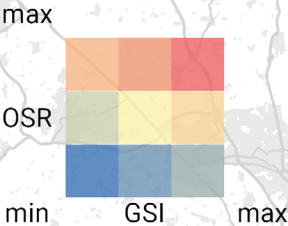
The analyzed agglomerations are characterized by a high level of Diversity of Urban Morphology Types. Often, high diversity is not accompanied by high values of other indicators of spatial development.



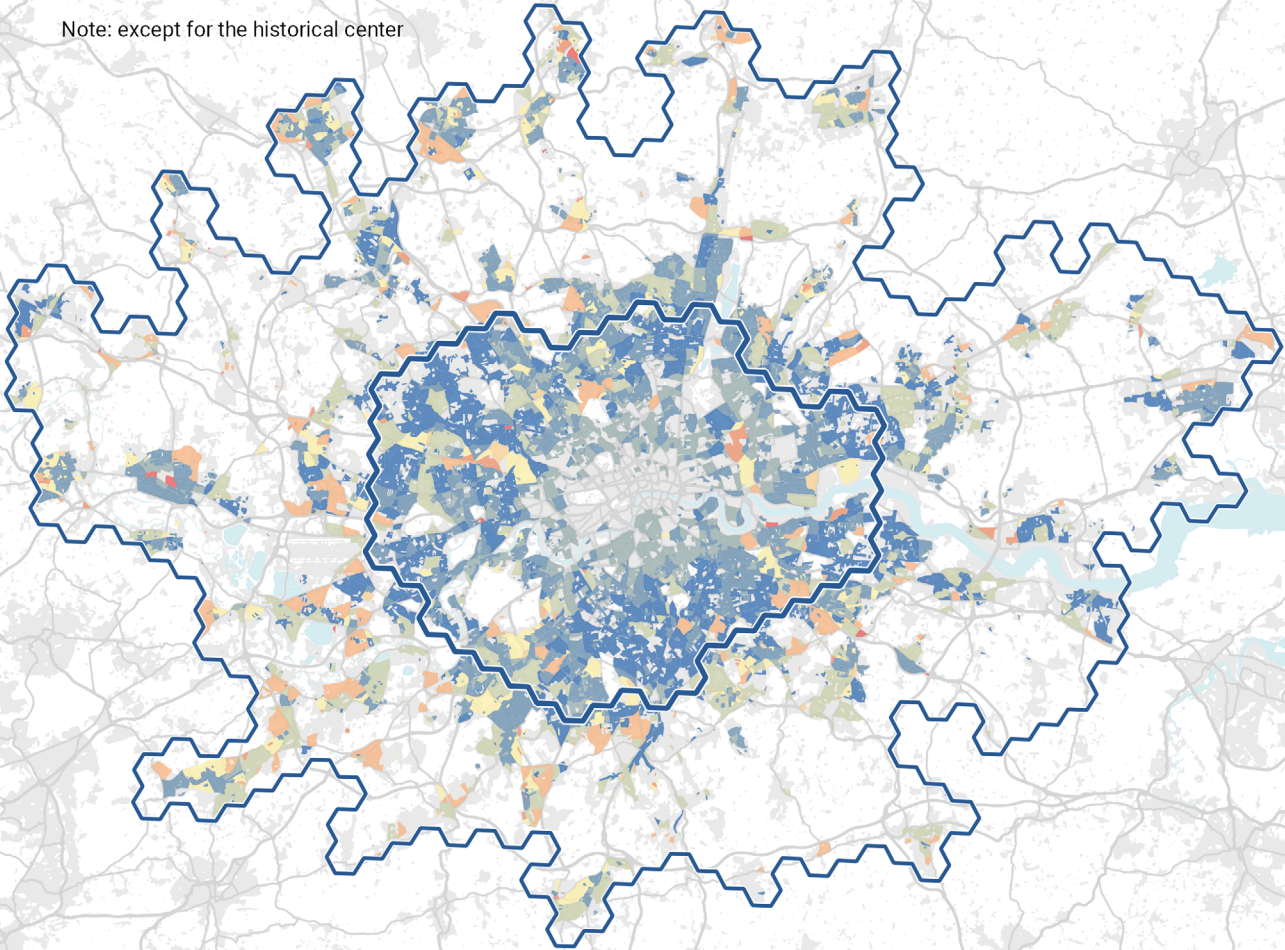
London – one of the Leaders in Europe in Diversity of Urban Morphology

0,76

– the Inverted Value of Herfindahl - Hirschman Index
for Open Space Ratio (OSR) and Ground Space Index (GSI)



Note: except for the historical center



- Urban Core
- High-Density Urban Area

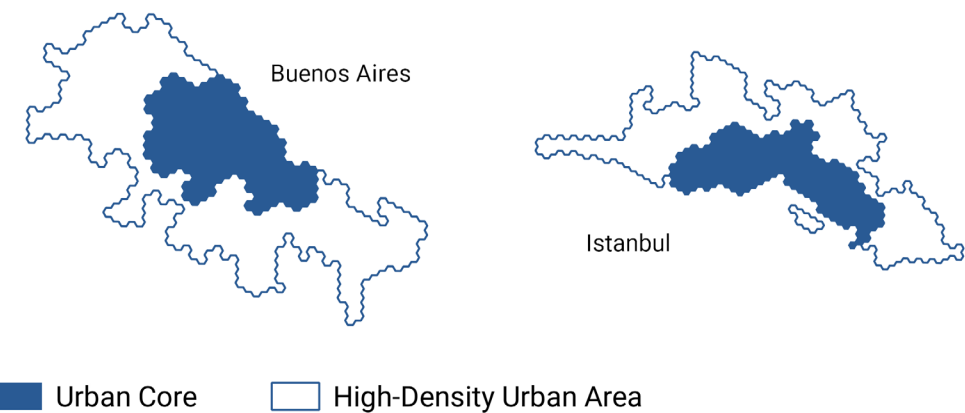
0 5 km

Group 3:
Diversity of Built Environment

— INDICATOR 6:

Accessibility of Green
Spaces

Figure 43:
Determination of Urban Boundaries:
Examples of Buenos Aires and Istanbul



Results Overview

Green spaces in a modern city directly influence the environment. They are also pillars of a comfortable urban environment. They enhance the quality of life by improving mental comfort, diversifying citizens' leisure time, and saving time by offering various recreational options, such as walking pets and spending time with children.

The sample agglomerations boast high accessibility of green spaces, with the median value of 91.4%. This represents the number of city residents living within a 15-minute walking distance from an at least 0.5 ha green area.

This indicator is heavily influenced by geographical factors. The physical and geographical location is the driver behind the ranking of agglomerations. Lower end of the list mainly includes cities located in relatively dry conditions. However, there are exceptions, such as Tokyo, Istanbul, Buenos Aires.

The leaders have at least 95% of the population living near large green areas, most of them European and Chinese cities, as well as Johannesburg and Sydney.

Berlin topped the list. The city is compact and yet widely known for over 100 of its parks. Its rich park history dates back to the 18th century royal gardens and spans hundreds of years to modern city parks, which have become a popular recreational destination for locals and tourists alike. At the same time, the green areas are distributed quite evenly, which contributes to the maximum accessibility indicator for the entire sample: in total, there are almost 4,000 green areas within the boundaries of the identified high-density urban area.

The average-performing group of cities has about 70%–95% of the population living within the 15-minute accessibility area, headed by Mumbai, followed by Tokyo. Tokyo is an illustrative example of the city that has it all: one of the largest agglomerations in the world, it does not lack greenery (there are over 20,000 green areas within the boundaries of a high-density urban area), but there are not many large green areas in the urban core. This, along with the huge population density, reduces the availability of green areas for city center residents.

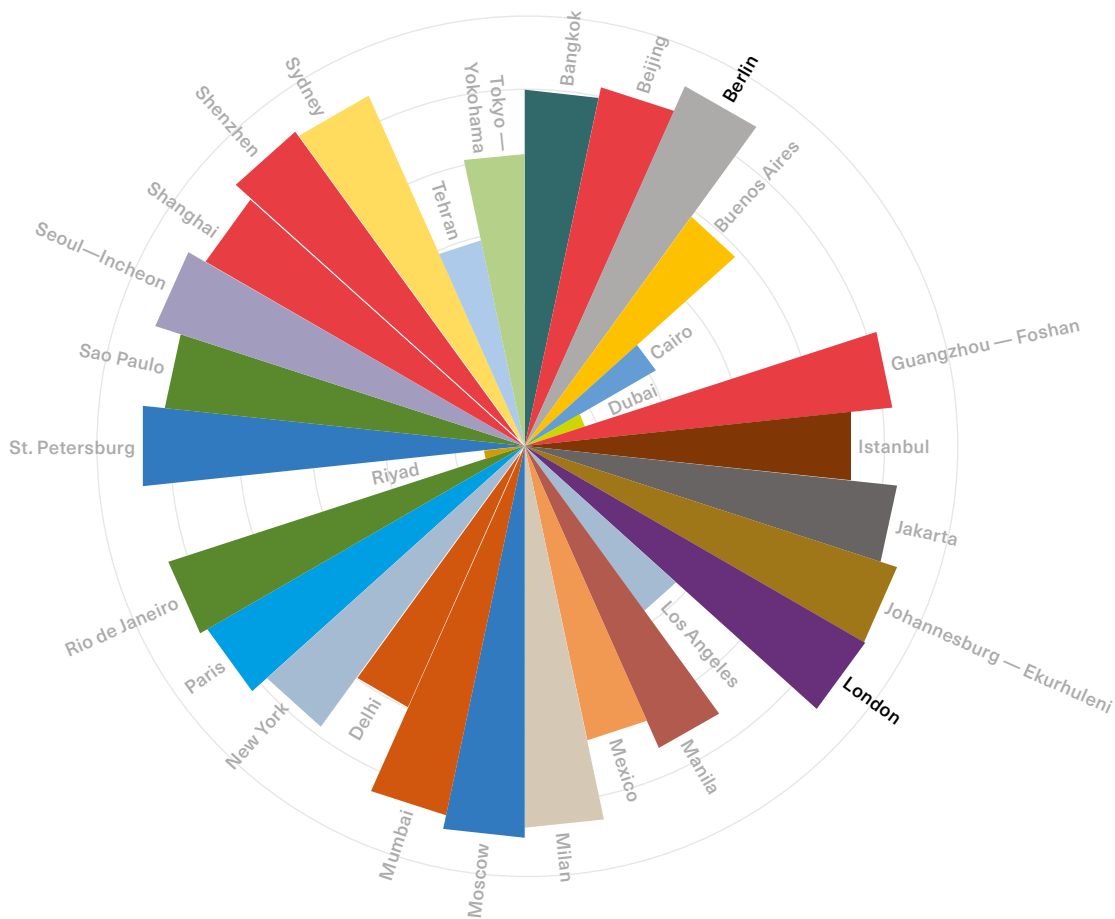
Figure 44.
Accessibility of Green Spaces

Rank	Agglomeration	Indicator's Score
1	Berlin	1,00
2	London	1,00
3	Johannesburg — Ekurhuleni	0,99
4	Moscow	0,99
5	Shenzhen	0,99
6	Seoul — Incheon	0,98
7	St. Petersburg	0,97
8	Sydney	0,97
9	Milan	0,96
10	Mumbai	0,95
11	Rio de Janeiro	0,94
12	Jakarta	0,94
13	Guangzhou — Foshan	0,93
14	Shanghai	0,93
15	Beijing	0,92
16	Paris	0,92
17	Sao Paulo	0,91
18	Bangkok	0,89
19	New York	0,87
20	Manila	0,82
21	Istanbul	0,81
22	Mexico	0,74
23	Tokyo — Yokohama	0,72
24	Delhi	0,70
25	Buenos Aires	0,69
26	Tehran	0,49
27	Los Angeles	0,47
28	Cairo	0,32
29	Dubai	0,08
30	Riyad	0,01

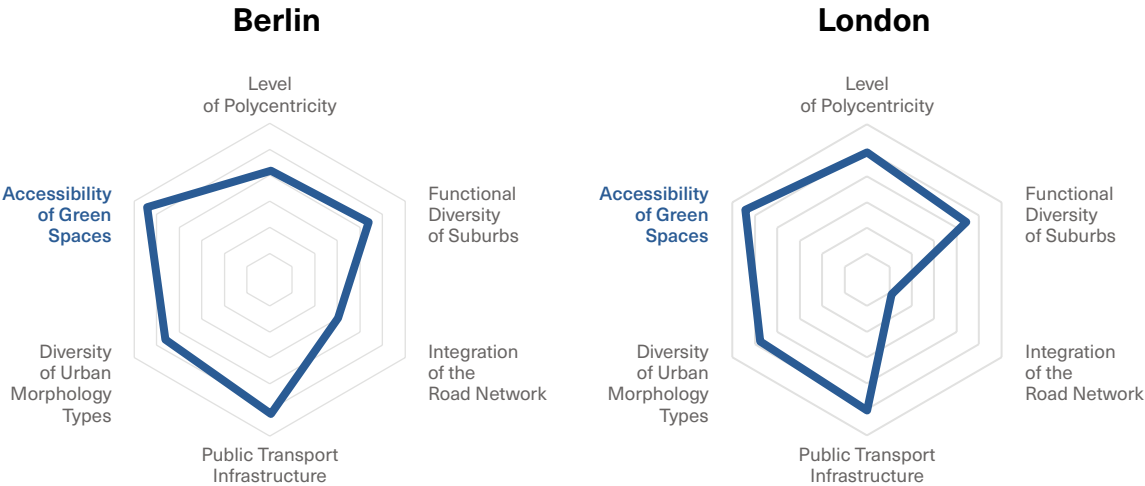
Note: May not sum to total due to rounding

Note: Due to the single variable the maximum normalized value does not mean the maximum possible value

Figure 45.
Accessibility of Green Spaces



The leading agglomerations — Berlin and London — are also distinguished by high values of the Diversity of Urban Morphology Types. Thus, green areas help to create a really diverse urban environment.



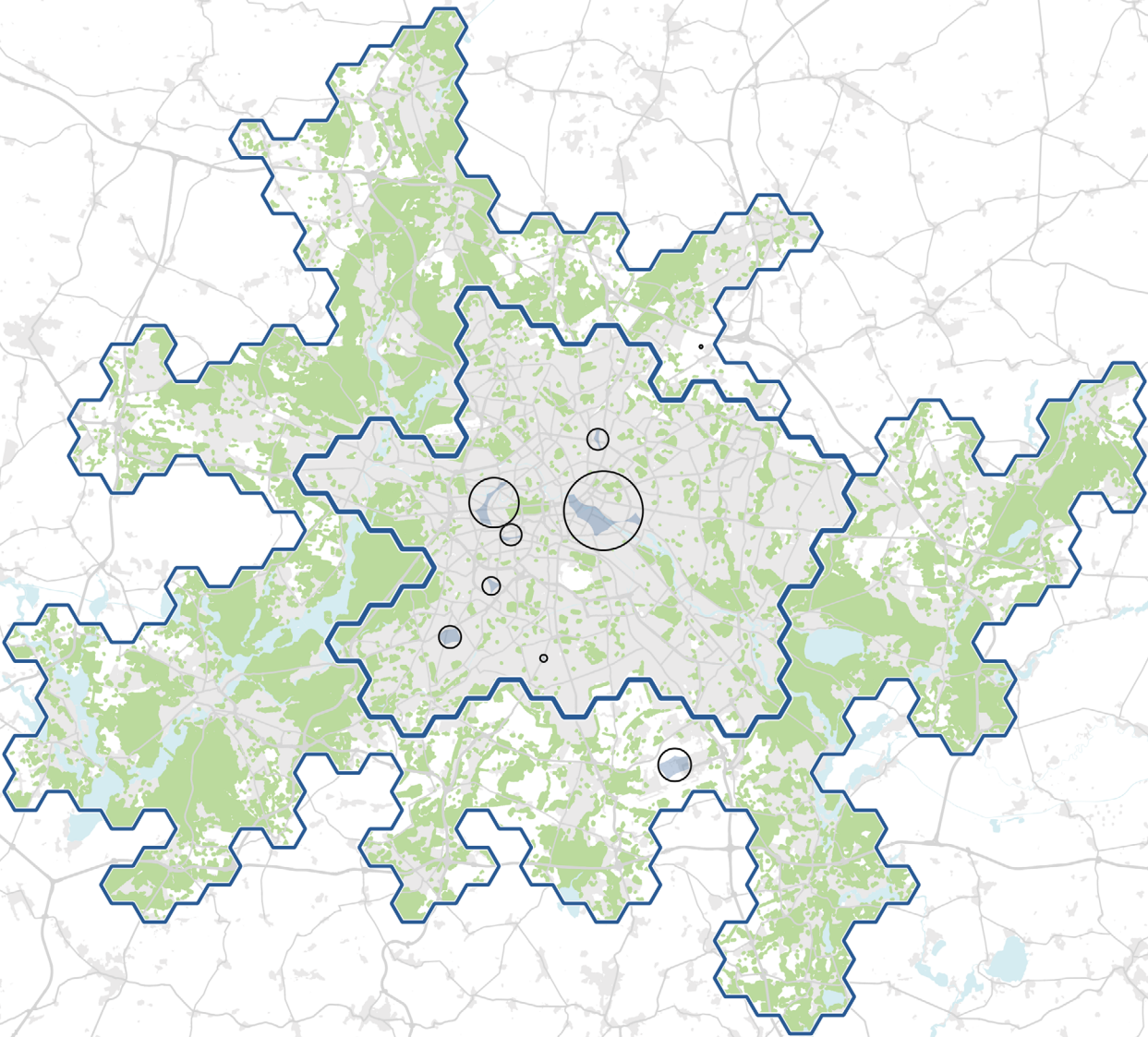
Berlin – a Leader in Accessibility of Green Areas

98,8%

**of its Population
have Pedestrian Access to Green Areas**



Territories inside a High-Density Urban Area
without Access to Green Areas



Urban Core



High-Density Urban Area

0

5 km



Conclusion

The Urban & Innovation Environment Index enables learning from the urban development experience: it highlights the best practices and warns against common mistakes. We summarized the key lessons the leading cities can share.

Seoul-Incheon: balanced development. Seoul's agglomeration leads in the final ranking, it has the highest scores on most of the Index indicators. This result requires high professional and managerial competence on the part of the city authorities, balanced attention to the different aspects of life and control of them.

London: tradition and innovation. London sets an example of a combination of traditions and innovations in urban policy. It allows the agglomeration to grow and develop without wasting the time of its residents. For example, the paid entrance to the city center and traffic regulation in it ensure a high availability of taxis.

Berlin: compactness and comfort. It is not necessary to be the largest city in terms of population to provide its citizens with quality services. Berlin proves the advantage of compactness, which can be enhanced by administrative and technological achievements.

Paris: diversity and heritage. Paris demonstrates that heritage conservation does not contradict urban development. Respect for history and urban environment diversity increases the value of a city dweller's time.

Moscow: controlled growth. Moscow agglomeration maintains a spatial balance at high urban growth rates. Public transport and polycentric development saturate the city's periphery, creating fast and comfortable provision of services.

Shanghai: digital transformation. Shanghai has chosen digitalization as a strategy which affects agglomeration development. Digital services cover not only the sharing economy and the delivery of goods, but also the public sector. It creates fast and convenient communication with the government, saving citizens' time.

We hope that the results of the Index show the urban development processes through the eyes of an ordinary citizen: a local, a tourist, or a migrant. In the spotlight of the Index are the time expenditures for daily activities, as an invaluable resource in modern metropolises, and the city's ability to reduce them. The balance between these two components is one of the most significant competitive advantages in the struggle for human capital.

This first volume of the rating is a pilot one. Next year our consortium plans to expand and deepen the analysis. Our goal — to make the Index a convenient and useful tool for assessing the effectiveness of urban development and its attractiveness for people.

- Andersen, T. B. (2009). E-Government as an anti-corruption strategy. *Information Economics and policy*, 21(3), 201-210.
- Berghauser Pont, M., & Haupt, P. (2007). The Spacemate: Density and the typomorphology of the urban fabric. *Urbanism laboratory for cities and regions: progress of research issues in urbanism*, 11-26.
- Brown, C. F., Brumby, S. P., Guzder-Williams, B., Birch, T., Hyde, S. B., Mazzariello, J., ... & Tait, A. M. (2022). Dynamic World, Near real-time global 10 m land use land cover mapping. *Scientific Data*, 9(1), 251.
- Brühlhart, M., & Sbergami, F. (2009). Agglomeration and growth: Cross-country evidence. *Journal of Urban Economics*, 65(1), 48-63.
- Demographia World Urban Areas. (2023). Retrieved November 24, 2023 from <http://www.demographia.com/db-worldua.pdf>
- Florida, R. (2002). *The rise of the creative class* (Vol. 9). New York: Basic books.
- Giffinger, R., Haindlmaier, G., & Kramar, H. (2010). The role of rankings in growing city competition. *Urban research & practice*, 3(3), 299-312.
- Gil-Garcia, J. R., & Martinez-Moyano, I. J. (2007). Understanding the evolution of e-government: The influence of systems of rules on public sector dynamics. *Government information quarterly*, 24(2), 266-290.
- Glaeser, E. (2011). Cities, productivity, and quality of life. *Science*, 333(6042), 592-594.
- Kasanko, M., Barredo, J. I., Lavalle, C., McCormick, N., Demicheli, L., Sagris, V., & Brezger, A. (2006). Are European cities becoming dispersed?: A comparative analysis of 15 European urban areas. *Landscape and urban planning*, 77(1-2), 111-130.
- Klemm, W., Heusinkveld, B. G., Lenzholzer, S., & van Hove, B. (2015). Street greenery and its physical and psychological impact on thermal comfort. *Landscape and urban planning*, 138, 87-98.
- Liu, D., Kwan, M. P., Kan, Z., & Wang, J. (2022). Toward a healthy urban living environment: Assessing 15-minute green-blue space accessibility. *Sustainability*, 14(24), 16914.
- Martens, K. (2012). Justice in transport as justice in accessibility: applying Walzer's 'Spheres of Justice' to the transport sector. *Transportation*, 39, 1035-1053.
- Mouratidis, K. (2021). Urban planning and quality of life: A review of pathways linking the built environment to subjective well-being. *Cities*, 115, 103229.
- Nakamura, R. (2008). Agglomeration effects on regional economic disparities: A comparison between the UK and Japan. *Urban Studies*, 45(9), 1947-1971.

Rice, P., Venables, A. J., & Patacchini, E. (2006). Spatial determinants of productivity: Analysis for the regions of Great Britain. *Regional science and urban economics*, 36(6), 727-752.

Saez, L., Heras-Saizarbitoria, I., & Rodriguez-Nunez, E. (2020). Sustainable city rankings, benchmarking and indexes: Looking into the black box. *Sustainable Cities and Society*, 53, 101938.

The Economist. (March 9, 2013). All Eyes on the Sharing Economy. Retrieved November 23, 2023 from <https://www.economist.com/technology-quarterly/2013/03/09/all-eyes-on-the-sharing-economy>

UN E-Government Knowledgebase. (2022). UN E-Government Survey 2022. Retrieved November 22, 2023 from <https://publicadministration.un.org/egovkb/en-us/Reports/UN-E-Government-Survey-2022>

UPU. (2022). Integrated Index for Postal Development (2IPD). Retrieved November 20, 2023 from <https://www.upu.int/en/Universal-Postal-Union/Activities/Research-Publications/Integrated-Index-for-Postal-Development>

Veneri, P. (2013). The identification of sub-centres in two Italian metropolitan areas: A functional approach. *Cities*, 31, 177-185.

Wang, R., Helbich, M., Yao, Y., Zhang, J., Liu, P., Yuan, Y., & Liu, Y. (2019). Urban greenery and mental wellbeing in adults: Cross-sectional mediation analyses on multiple pathways across different greenery measures. *Environmental research*, 176, 108535.

WIPO. (2023). Global Innovation Index 2022. Retrieved November 23, 2023 from https://www.wipo.int/global_innovation_index/en/2022/

International Consortium



Guangdong CIS Alliance
for International Science
and Technology Cooperation



South China University
of Technology



Guangzhou Academy
of Social Sciences



HSE Faculty of Urban
and Regional Development



Jindal Global
University

