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Can Budapest Be the Smartest City in Eastern and Central Europe?

Introduction

According to OECD forecasts, by 2100, 85% of the world's population will live in cities (up from today's 55–56%). Cities already account for 82% of global GDP, and projections suggest this could rise to 88% by 2025.[1] Alongside the concentration of population and global GDP, the largest cities are also hubs for capital (e.g. in the form of stock exchanges) and corporations. The Fortune Global 500 list shows that 21%, or 105 companies, are concentrated in the four global cities: London, New York, Paris, and Tokyo.[2]

The McKinsey Global Institute examined the world's 600 largest cities (including Budapest, the capital of Hungary) based on their contribution to global GDP growth between 2007 and 2025. It was found that approximately 1.5 billion people (22% of the world's population) live in these cities, which produced USD 30 trillion in GDP in 2007 (over half of global GDP), with an average GDP per capita of USD 20,000. These figures are expected to increase significantly across all three examined metrics by 2025. The population is projected to grow to approximately 2 billion, with improving average living conditions. The total GDP of the 600 cities is expected to reach USD 64 trillion, with average GDP per capita projected to be 1.5 times the 2007 level, amounting to USD 32,000.[3]

Nowadays, Industry 4.0 and globalisation are presenting new challenges to cities with technologies such as artificial intelligence, autonomous vehicles, 5G networks, and big data. In many cases, cities need to think in terms of new business models to overcome these challenges.[4] This is because rapid urbanisation brings with it numerous challenges, such as the growth of slums or the increasing pressure on basic services and infrastructure, as well as uncontrolled city expansion, all of which heighten the vulnerability of cities to economic and environmental shocks.[5] The rapid growth in the size and population of cities therefore – alongside economic factors – has a significant impact on society and the environment.[6] This highlights the significance of resilience, which refers to the ability to adapt to rapidly changing external conditions and manage shock-like external impacts.

1 OECD 2015: 15.
2 Fortune 2022.
3 Dobbs et al. 2011.
4 Budapest Főváros Önkormányzata 2019a: 10.
5 *Discover the Most Sustainable Cities in the World* 2021: 1.
6 Perveen et al. 2017: 666.

DOI: https://doi.org/10.36250/01242_10

In 2017, Kumar and Dahiya emphasised this by developing a maturity model for smart cities, where the first level represents access to basic urban services. This progresses through effective resource and energy use and sustainability, with the final stage aiming for cities to achieve a high level of resilience.[7] Analyses suggest that Covid–19 has further accelerated the shift towards a new urban paradigm, which could result in inclusive, green, and smart cities in the long term.[8]

The concept of a 'smart city' is a widely used term as an urban economic development driver, which can achieve significant increases in efficiency through the extensive adoption of new technologies.[9] However, these new technologies often involve the structural transformation of city economies and the automation, co-ordination, and system-level management of their processes. Change is not limited to megacities; for instance, at a global level, the most radical population growth and economic transformation are expected in the second- and third-tier cities of various countries.[10] In this approach, the innovation capacity of cities in the Eastern and Central European region (such as their role in smart city development) is of particular importance, as surrounding regions could also significantly benefit from their development, which could support their convergence towards the EU average.[11]

The aim of this chapter is to position Budapest as a smart city within the Eastern and Central European region, to present its strategy, and to review the anticipated developments. After introducing the smart city concept, the second part of the chapter presents the Hungarian capital's strategy across various focus areas, and then positions it among the broader group of Eastern and Central European capitals (Prague, Bratislava, Warsaw, Bucharest, Sofia, Zagreb, Ljubljana)[12] in light of key smart city rankings. The chapter concludes with a forecast of the city's expected position.

1. Theoretical overview

The smart city concept emerged in the academic literature in the 1980s and 1990s and refers to a city driven by information and communication technologies (ICT). Since its inception, numerous interpretations have been proposed to describe the concept, but there is still no accepted definition today.[13] Below, I will review several concepts related to smart cities, outlining the noticeable differences among them.

[7] Vinod Kumar – Dahiya 2017: 74.
[8] OECD 2020.
[9] Kollar et al. 2018: 7.
[10] World Economic Forum 2022.
[11] Kollar et al. 2018: 7.
[12] The broader concept of the Eastern and Central European region is justified by similar starting conditions, historical factors, strategic co-operation and socio-economic characteristics.
[13] O'Grady–O'Hare 2012: 1581–1582.

1.1. The concept and models of smart cities

Initially, the use of ICT (Information and Communication Technology) defined smart cities. Over time, more 'soft' elements (such as knowledge, human capital, and the role of innovation) have been incorporated into definitions, and today, participation and sustainable development are increasingly emphasised. Some approaches focus on ICT (buzzwords: 'digital', 'connected', or 'information-rich' cities),[14] while others stem from environmental considerations ('sustainable', 'green', 'eco' cities)[15] or knowledge aspects ('learning' or 'intelligent' cities)[16] and transport perspectives. What they have in common is the portrayal of cities as places that house efficient, highly productive, innovative, and collaborative communities.[17] One of the most frequently used models is the six-component model developed by Giffinger and co-authors (originally applied to medium-sized European cities), which includes economy, people, governance, mobility, environment, and quality of life,[18] using over 80 indicators in total to rank cities.[19]

In another point of view, a smart city is characterised by only two main features: technology and the creation of added value for stakeholders. The city administration aims to ensure quality of life, business opportunities, competitiveness, and cost reduction within a specific, well-defined geographical area.[20]

Alongside research institutions and experts, major international organisations and institutions also articulate their own perspectives. According to the UN's urban development programme, a smart city is a concept that leverages the opportunities provided by digitalisation, clean energy and technologies, as well as innovative transport technologies, thereby offering residents environmentally friendly decision-making and choice options. As a result, it supports sustainable economic growth and improves the services provided by cities.[21]

According to the most recent approach of the European Commission, a smart city is "a place where traditional networks and services are made more efficient with the use of digital solutions for the benefit of its inhabitants and business".[22]

Several theories focus on summarising the common intersections of various definitions and interpreting the concept in a holistic manner. The majority of these approaches review the literature from the perspective of the ultimate goal of smart cities, which is the quality of life for residents. For example, the IoT agenda starts from the technology

[14] Hollands 2008.
[15] Bătăgan 2011: 80–87.
[16] Komninos 2011: 172–188.
[17] Lazaroiu–Roscia 2012: 332.
[18] Giffinger et al. 2007: 11.
[19] Among European medium-sized cities with a population of between 100,000 and 500,000 (with at least one university centre and an agglomeration zone of less than 1.5 million inhabitants), Luxembourg is the 'smartest', ahead of Aarhus and Turku. Overall, the northern medium-sized cities led the ranking.
[20] Glasmeier–Christopherson 2015: 6.
[21] UN 2017: 19.
[22] European Commission [s. a.]: 1.

side and identifies several common elements in definitions of smart cities, including: technology-based infrastructure, environmental initiatives, a well-functioning public transport system, effective urban planning methods, and people who live and work in the city and utilise its resources.[23]

The capital city's smart city strategy defines the concept as a set of measures aimed at improving urban quality of life in the long term, with a focus on people and a liveable urban environment.[24] Additionally, the term 'smart' is also used as an acronym, as their interpretation suggests that a development achieves its true goal if it is "S.M.A.R.T. – Specific, Measurable, Attainable, Relevant, and Time-bound".[25]

The following model provides a summary of the framework conditions for smart cities. The central element of the model is the six components of smart cities – smart economy, people, governance, mobility, environment, and quality of life – based on the models by Giffinger and co-authors[26] or Cohen.[27] Nam and Pardo extend the basic model by adding three so-called boundary conditions that influence the model's success. These can be categorised into: human factors (human preferences, labour market characteristics), technological factors (technological development and digitalisation), and institutional factors (elements of the regulatory environment).[28] Fernandez-Anez and co-authors have further developed the model by incorporating global trends affecting cities, which is an important consideration in today's rapidly changing urban environment. These global trends include climate change, the increasing significance of new technologies, economic instability, global urbanisation, demand for new governance models, and social polarisation. For example, economic instability here refers to economic resilience, vulnerability, innovation, knowledge-based economy, and competitiveness.[29]

I have supplemented this framework model with a few additional conditions, as I believe the entire model is strongly embedded in a macroeconomic business environment with distinct characteristics and incentives that vary by country. This environment is fundamentally shaped by the asymmetric interdependencies among countries, regions, and cities *(Figure 1).* In my opinion, this influences the possibilities and success of financial and professional support for individual smart city initiatives.

[23] Brown 2018.
[24] Budapest Főváros Önkormányzata 2019a: 4.
[25] Budapest Főváros XIII. Kerületi Önkormányzat 2019: 5.
[26] Giffinger et al. 2007: 12.
[27] Cohen–Obediente 2014.
[28] Nam–Pardo 2011: 286.
[29] Fernandez-Anez et al. 2018: 78.

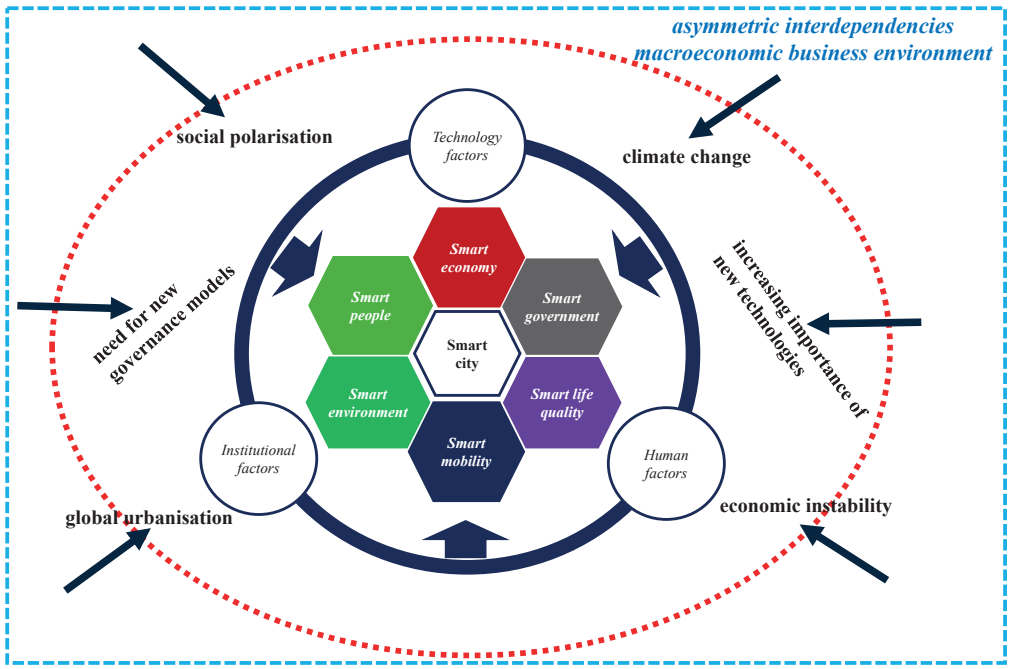

Figure 1: Smart city framework model

Sources: compiled by the author based on the model of Giffinger et al. 2007; Nam–Pardo 2011; Fernandez-Anez et al. 2018

1.2. Smart city strategies: Variations in planning directions and management models

In addition to the focus areas (number and nature of components), theories can be clustered based on other aspects, such as the method of strategy development (top-down, bottom-up, or co-creation planning),[30] the number of stakeholders involved (triple, quadruple, or even penta helix approaches), or the role of ICT tools used.[31]

Urban development today has undergone a paradigm shift in several respects, and research activities related to smart cities have become a priority for all stakeholders (business sector, industry, policymakers, and the academic community).[32] The involvement and collaboration of different stakeholders vary from city to city, and there is no uniform framework for this. Consequently, depending on the number of stakeholders, the direction of strategic planning may also vary, reflecting the unique needs and contexts of each city.

According to Jong and co-authors, the concept of a smart city is based on the ideas of intelligent and creative cities. The former, which can be traced back to the earliest

[30] Budapest Főváros Önkormányzata 2019a: 6.
[31] Szendi 2021: 173.
[32] Eremia et al. 2017: 12.

top-down approach, focuses on technology, while the latter is rooted in a bottom-up, community-based and private sector-driven approach. The ideal smart city combines these elements, being both smart and creative, which implies a balanced relationship between technology, institutions, and people.[33]

When involving stakeholders, three relevant approaches should be mentioned. The oldest is the so-called triple-helix model, which is based on the collaboration of the public, private, and academic sectors and primarily creates projects through a top-down approach. In this model, civic engagement is relatively weak.[34] In contrast, the quadruple-helix model integrates civil society as well, allowing for a more flexible response to social issues and establishing an institutionalised bottom-up approach for problem-solving. This provides a reactive solution to emerging problems and societal risks.[35] Recently, a new model for idea generation, the penta-helix approach, has emerged, which proactively integrates the participation of social entrepreneurs and activists.[36] This helps better address problems arising from a changing environment and can enhance the resilience of cities. Since cities are responsible for a significant portion of environmental issues, environmental protection has also been incorporated into the helix models. While the classic triple and quadruple helix approaches remain, the five-component penta-helix model sometimes evolves into a quintuple helix model, where the fifth pillar is the environment as a framework condition.[37]

Building on the penta-helix approach, the Smart City 3.0 theory is becoming increasingly popular today, which adopts a population-driven approach. Leading smart cities are beginning to apply co-creation strategies to jointly develop technologies and services desired by their residents.[38]

1.3. Smart city strategies and models in the capitals of the Eastern and Central European region

An examination of the capitals in the Eastern and Central European region reveals a diverse range of city management models. Due to their post-socialist heritage, most cities rely on top-down, centrally controlled models for their strategies (as also observed in the capital), a trend supported by existing literature.[39] However, it has become increasingly evident that several cities recognise the importance of more intensive involvement from the population and civil society to ensure social acceptance of their projects. In this review, I analyse the strategy development processes of the broadly defined capitals in Eastern and Central Europe, aiming to determine whether each city has a comprehensive

[33] Jong et al. 2015: 27.
[34] Calzada–Cowie 2017: 25–28.
[35] Szendi 2021: 173.
[36] Calzada 2020: 1150.
[37] König et al. 2021: 9.
[38] Paskaleva et al. 2021: 399.
[39] Sagan–Grabkowska 2012: 1142; Ibănescu et al. 2020: 79; Nedučin et al. 2021: 23.

smart city strategy and to assess the orientation of their strategy development, idea generation, and implementation (whether top-down or bottom-up). The details of the region's models are comprehensively summarised in *Table 1.*

Table 1: Capital cities in Eastern and Central Europe according to the urban governance models used in smart city strategies

Country	Capital	Existence of a complex smart city strategy	Orientation of the strategy
Bulgaria	Sofia	not	top-down
Czech Republic	Prague	yes (2017–2030)	top-down and bottom-up
Croatia	Zagreb	yes (2020–2030)	top-down and bottom-up
Hungary	Budapest	yes	top-down or bottom-up at district level
Poland	Warsaw	yes	top-down
Romania	Bucharest	not	top-down
Slovenia	Ljubljana	not	top-down and bottom-up
Slovakia	Bratislava	no/forming on the model of Vienna Twin City	top-down

Source: compiled by the author

Reviewing the strategies of individual cities reveals the following observations. In the case of *Sofia,* there is no comprehensive smart city strategy that covers all areas. However, there are forward-looking initiatives. In 2020, Sofia adopted a digital transformation strategy as a result of its participation in the European Commission's 'Digital Cities' challenge (2018–2019). The declared goal of this challenge was to achieve sustainable economic growth through the use of cutting-edge technology.[40] Additionally, within the framework of the 'Smarter Together' programme, Sofia has established a sustainable energy action plan for the period 2012–2020. This plan includes measures for energy management, energy planning, and building refurbishment, as well as for transport and waste management.[41] In 2019, the city administration introduced the 'Vision for Sofia 2050' initiative, which is a joint and long-term strategy for the development of the capital and its suburban areas up to 2050, which is planned to be implemented with the combined participation of citizens, businesses, academia, non-governmental organisations, and government officials.[42]

In contrast, *Prague* has a comprehensive smart city strategy for 2030, with its main goals being sustainable growth and a high quality of life. Projects are implemented according to five core principles: the city aims to be eco-conscious, innovative, friendly and motivating, digitised, secure and resilient. Progress is monitored annually, and results are reviewed. Six key areas have been identified where the introduction of modern technologies is expected to have the greatest positive impact: future mobility, smart buildings and energy, a waste-free city, attractive tourism, people and urban environment,

[40] European Commission 2019: 4.
[41] *Smarter Together: Sofia* 2019.
[42] Sofia Municipality 2017.

and data processing. The strategy incorporates both top-down and bottom-up elements, as the city administration plans and executes projects in the key areas, but project ideas can come from a wide range of sources, including the population, businesses, academic and research institutions, and local authorities.[43]

By 2030, *Zagreb* has established a framework strategy for smart city development, with key elements including quality of life, the economy, management and information, as well as environmental protection and climate change mitigation. One of the main focuses of the strategy is sustainability, with emphasis on areas such as energy networks, smart management of energy supply, water supply and sewage systems, as well as smart management of gas networks and street lighting.[44] The measures are always directed by the same team, which includes multiple stakeholders, continuously monitoring and improving the projects in a sort of 'living lab' approach.[45] The city builds on involving local actors both in idea generation and implementation, similar to Prague, using a governance model that combines both top-down and bottom-up approaches.[46]

Regarding *Warsaw*, the city's primary goal is to improve the quality of life for its citizens, and according to its strategy, it aims to become a mature, digitally advanced city in Eastern and Central Europe by 2030. Additionally, it will be a place that generates innovation and attracts international talent. Current solutions focus on the sensor-based collection and monitoring of data, and goals/key dimensions are defined based on the six components outlined by Giffinger and co-authors, which are implemented within a historically well-established top-down governance model (with a prominent role for the Warsaw City Hall).[47]

The municipal administration of *Bucharest,* in collaboration with Deloitte, is developing its smart city strategy by 2025, which is currently in the design and consultation phase, so specific goals are not yet known.[48] Bucharest began planning its smart city strategy in 2018, focusing largely on traffic management, transport infrastructure, e-governance, telecommunications, smart buildings, green energy, public safety, and smart tourism. The two main pillars are the transport and governance components. During the strategy development phase, the city exhibits strong top-down characteristics.[49]

Ljubljana does not have a comprehensive strategy in place (despite working with Siemens on the city's smart strategy since 2010).[50] However, as the European Green Capital in 2016, the city places a strong emphasis on sustainability in urban development.

[43] Deloitte Česká Republika 2022: 88.
[44] Malnar Neralic 2019: 8.
[45] Classic examples include certain districts of Amsterdam and Helsinki, where specific project proposals are tested and, if successful, they can be expanded to the entire city or adopted as best practices by other cities.
[46] Zagreb (HR) 2019.
[47] Giffinger et al. 2007: 12; Baker 2019: 4; Masik et al. 2021: 4.
[48] Romania Insider 2018.
[49] Ibănescu et al. 2022: 249.
[50] Pušnik et al. 2019: 143.

Ljubljana attempts to integrate citizens into the smart city development process, primarily through idea generation, thereby incorporating a bottom-up perspective into strategy formulation, similarly to Zagreb.[51]

Bratislava also lacks a complex smart city strategy. Several strategic documents have been developed for various sectoral advancements (such as the strategy for climate change adaptation, transport, social, and environmental studies), but a holistic smart concept for the city has yet to be completed.[52] The forthcoming strategy is likely to follow the Vienna model as part of the so-called Twin City project, which suggests a top-down approach.

Overall, among the capitals in the region, four still employ a top-down approach (see *Figure 2*), while in three cases, including Budapest at the district level, bottom-up initiatives are strongly present in the idea generation and strategy implementation phases.

As can be seen, there is no unified perspective on strategic planning within the V4 countries, but it is also evident that the capitals of countries with higher per capita incomes are more inclined towards the bottom-up approach. Thus, in the western part of the region, capital city strategies typically materialise in the spirit of co-creation, in a complex manner.

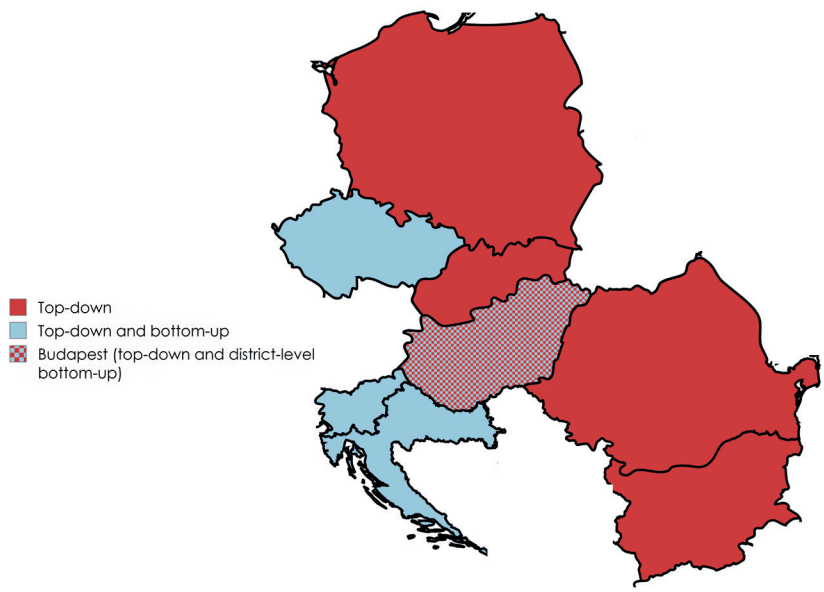

Figure 2: Smart city strategies of the ECE region's capital cities
Source: compiled by the author

[51] European Commission 2020.
[52] Husar–Ondrejicka 2016.

2. Key elements of Budapest's smart city strategy

In the following section, I will review the main objectives of Budapest's smart city strategy, the process of its development, its comprehensive and detailed focus areas, as well as specific features affecting the individual districts and potential connections with other strategies.

2.1. Smart city framework – Budapest's smart city model

Since the early 2010s, and in some cases even earlier, the development of smart city strategies has been initiated in an increasing number of EU capitals. Budapest's smart city framework strategy was adopted in 2019, with significant inspiration drawn from Vienna's smart city strategy. Vienna's top-down approach to smart city development, similar to Budapest's, defines the main development directions for sectoral planning, which then break down into specific strategic goals.[53] During the planning phase, the city reviewed several European examples concerning directions and actual project proposals,[54] however, the Vienna strategy was the closest to Hungarian concepts, which are internationally competitive smart city ideas (ranked 11th by IMD [Institute for Management Development], and 18th in the world according to the IESE [IESE Business School University of Navarra] index).[55]

The strategy's background partly includes Budapest 2030 Long-Term Urban Development Concept (which was already established in 2013) and Budapest Smart City Vision. The latter was completed in 2017, based on the goals of Budapest 2030 and sectoral plans. Among its main objectives are the following *(Table 2)*, which provided the foundation for defining the city's vision for the future.

Table 2: Objectives of Budapest 2030 and Smart City Vision

Budapest 2030 Long-Term Urban Development Concept	Budapest Smart City Vision
Budapest as a strong member of the European region	International innovation hub
	Environmentally friendly use of resources and waste
Improved quality of life	Sustainable mobility
Value- and knowledge-based, sustainable economy	A city responding to environmental and technological changes
	Open, co-operative society
	Sustainable, local economic development

Source: Budapest Főváros Önkormányzata 2019a: 6–7

[53] Dobos et al. 2015: 84.
[54] Budapest Főváros Önkormányzata 2019b: 128.
[55] Both indices rank smart cities according to different dimensions (see section 3.2 of this chapter for details).

With a view to the above considerations, Budapest's smart city vision is as follows: "Smart Budapest is a city that is environmentally, socially, and economically sustainable. By leveraging modern technology and fostering greater societal engagement, it aims to be a liveable city for its residents."[56] In other words, the capital's strategy strongly emphasises all three pillars of sustainability – environmental, social, and economic – as well as the crucial aspect of liveability. This liveability is to be enhanced through the opportunities offered by digital technologies. Furthermore, the strategy underscores the importance of societal engagement, which not only supports social acceptance of the goals but also helps achieve the desired outcomes.

In implementing the strategy, Budapest relies on the involvement of multiple stakeholders. Alongside the municipal government, state administrative bodies are responsible for enforcing the strategic principles in urban development and providing the regulatory framework needed to support the implementation of the strategy. Additionally, during both the planning phase and implementation (including monitoring the achieved results), there is a strong emphasis on involving the public and the civil sector. Meanwhile, market enterprises are primarily responsible for developing the products and services necessary for implementation *(Figure 3).* Thus, the top-down nature of the strategy is somewhat mitigated by its inclusion of stakeholders at various points, and it employs a kind of institutionalised bottom-up approach with the participation of civil organisations,[57] using a quadruple helix model.

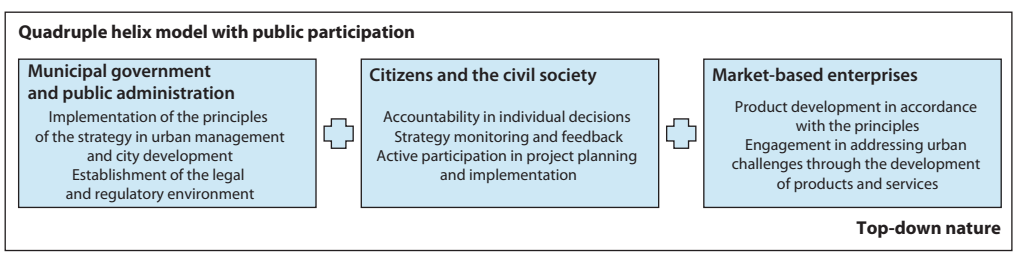

Figure 3: Governance model and stakeholders of the Smart Budapest framework strategy
Source: compiled by the author based on Budapest Főváros Önkormányzata 2019a: 13

The smart city strategy encompasses a total of 6 focus areas and 11 principles. Among the 6 focus areas, the model by Giffinger and his co-authors[58] may be most prominently mentioned, as it bears the greatest similarity, albeit in a slightly refined version (including proactive city governance, smart people, smart economy, sustainable resources, smart mobility, and urban quality of life). The 11 principles that organise the strategy primarily aim to support these components and generally reflect a holistic approach. The 11 principles are: efficient, co-operative, environmentally conscious, value-preserving and

[56] Budapest Főváros Önkormányzata 2019a: 7.
[57] Calzada 2020: 1148.
[58] Giffinger et al. 2007: 12.

value-creating, flexible, forward-looking, supportive (solidarity), creative, awareness-raising, secure, and transparent.[59] Each principle points towards a sustainable, liveable city capable of flexibly and swiftly responding to changes in the external environment and proactively managing shocks. In project planning, it relies on the creative knowledge and intellectual capital of its residents, while also shaping it through the implementation of developments. For each focus area, the plan specifies the main objectives of the respective pillar and assigns possible tools for implementation. These key points are summarised in the following diagram, based on the logic of Giffinger and his co-authors.[60]

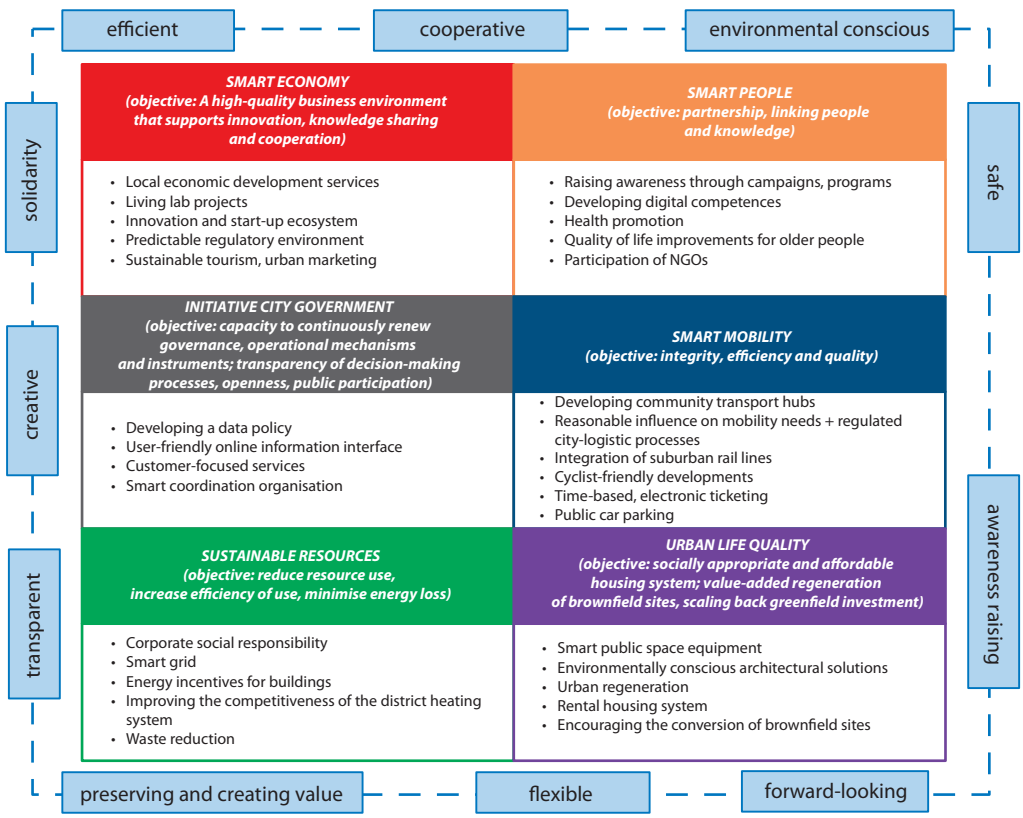

Figure 4: Focus areas and principles of the Smart Budapest Strategy in the light of the objectives and possible solutions

Source: compiled by the author based on Budapest Főváros Önkormányzata 2019a: 11–12

[59] Budapest Főváros Önkormányzata 2019a: 16.
[60] Giffinger et al. 2007: 11.

Based on the above, Budapest faces significant challenges in all focus areas, and numerous solutions have been proposed to address them. Some of these are very specific, direct project proposals that have already begun planning (such as the creation of a living lab, development of digital competencies, data policy development, time-based electronic ticketing system [RIGO system], smart grid, smart street furniture), while others are comprehensive project proposals (e.g. innovation and start-up ecosystems or encouraging the functional transformation of brownfield sites). Implementing these, considering the named principles of the strategy, could significantly contribute to Budapest's long-term competitiveness among smart cities in Eastern and Central Europe. To support implementation, the Smart Budapest Community has been established. This community is designed to use its knowledge capital from the innovative entrepreneurial ecosystem and strengthen connections among innovators to discuss, review, implement, support, and represent Budapest's smart city-related policies.[61]

2.2. District-level smart city strategies for Budapest

Budapest's smart city strategy is complex not only in terms of the six focus areas mentioned but also geographically integrated. Some districts have their own smart district strategies, applying a kind of 'city within a city' approach. The unique aspect of these district strategies is that they often provide experimental environments for start-ups, similar to the living lab areas in Amsterdam or Helsinki (e.g. the smart city strategy for Józsefváros). They also adopt a strong bottom-up or co-creation approach (both District XIII and Józsefváros follow similar strategies). This bottom-up approach aims for stronger collaboration with civil society, which can be more feasibly implemented on a smaller scale within districts than across the entire capital. This approach improves the social acceptance of the strategies and allows for a response to actual emerging needs. If the district-level living lab projects are successful, their developments can be extended to other parts of the city or to the entire city itself. In the following, I will review the smart strategies of a few districts and examine how they might contribute to the city's goals set for 2030.

On 7 February 2019, the municipal government of District XIII (including Angyalföld, the Göncz Árpád City Center, the southern part of Népsziget, and the quarters of Újlipótváros and Vizafogó) adopted the Smart District Concept, which outlines the foundations of its smart district strategy.[62] The district's concept is based on the six components outlined by Giffinger and co-authors,[63] similar to the city's comprehensive strategy. However, when defining its goals, four main directions were identified, reflecting the district's unique features: development of an integrated municipal public service

[61] MTI 2021.
[62] Budapest Főváros XIII. Kerületi Önkormányzat 2019: 14.
[63] Giffinger et al. 2007: 12.

system, improvement of citizens' living conditions, reduction of ecological footprint (energy efficiency), and support for active participation (e-services). The realisation of these goals is envisioned through four project packages: partner card service, development of partner-centred public services, 'Smart Net' for the benefit of residents and visitors, and a public parking system.[64] The partner card service has been operational in the district since 2009, and today more than 50% of the population uses it. With the card, users can receive discounts at shops in District XIII, in social stores, and for accessing public services. Currently, a smart application also supports even easier use (e.g. real-time messages about important events specific to streets) and the application process. Additionally, more free Wi-Fi access points have been established throughout the district.[65] In District VIII (Józsefváros), the smart city strategy was developed earlier. The municipal government first adopted the district's digital strategy in 2015, and then, in 2016, the Smart City Working Group was set up, which developed the outline of the concept later that year.[66] According to the strategy's vision, the goal is to create a 'balanced, culturally diverse, economically distinctive, and efficiently/smartly managed green inner-city district',[67] built upon the six components defined by Giffinger and co-authors.[68] A key element of the strategy is the establishment of living lab areas, which are considered one of the priorities in several areas and are deemed feasible with the involvement of universities and public institutions.

The city features several smart solutions and completed projects across various districts, such as smart benches in District II, smart paving stones in District IV, a project awarded for telemedicine services development in District VII, smart homes in Kőbánya, and a public space fault reporting application in Budafok. However, among the comprehensive strategies, the two mentioned above are the most extensive.

2.3. Regional co-operation and Budapest's smart strategy

The degree of integration is enhanced by the emphasis on city-regional collaborations in both Budapest's smart city strategy and its Integrated Urban Development Strategy, reflecting a key objective of the EU.[69] The smart city strategy highlights the need for collaboration and joint planning among partners to ensure the success of developments. This is crucial because one of the main goals of the city's long-term development strategy is to strengthen Budapest's role as a connecting hub in west–east and north–south directions within innovation, economic, cultural, and decision-making processes.[70] As regards

[64] Budapest Főváros XIII. Kerületi Önkormányzat 2019: 13.
[65] Budapest Főváros XIII. Kerületi Önkormányzat 2019: 13.
[66] Smart City Strategy for Józsefváros 2018: 4.
[67] Smart City Strategy for Józsefváros 2018: 10.
[68] Giffinger et al. 2007: 12.
[69] Budapest Főváros Önkormányzata 2019a: 49; 2021: 6–7.
[70] Urban Development Department of the Metropolitan Government of Budapest 2014: 32.

regional collaborations, the Budapest Metropolitan Region's Regional Development Strategy, completed in 2011, provides answers from several perspectives. The Budapest metropolitan area exhibits strong polycentric urban characteristics. The capital is surrounded by several cities with populations between 50,000 and 100,000, within a radius of 60–80 km (Székesfehérvár, Dunaújváros, Kecskemét, Szolnok, Gyöngyös–Hatvan, Salgótarján, Esztergom, and Tatabánya). These are the primary urban centres that define themselves as vibrant business hubs and attractive residential areas within the integration zone of the larger metropolitan region.[71] The strategy identifies Budapest as a potential MEGA (Metropolitan European Growth Area) region, which, according to the ESPON (European Spatial Planning Observation Network) classification, are prominent growth centres among European cities. Among the MEGA regions in Europe, the so-called Pentagon Area covers the most significant growth zone (with endpoints in London, Hamburg, Munich, Milan, and Paris).[72] In contrast, analysts view the so-called Central European Danube Integration Zone as a counterpoint. This zone covers the area enclosed by successfully specialised Central European metropolises, with key nodes such as Prague, Vienna and Bratislava (twin cities), as well as Budapest and Ljubljana.[73] It emphasises that co-operation among cities in smart strategies can further enhance the significance of the region.

In Budapest's future development, the above analysis considers five possible scenarios: 1. Spontaneous Growth Scenario (continuation of the previous unmanaged development path); 2. Self-contained City Scenario (minimum role of the agglomeration); 3. Danube Development Axis Scenario (with sub-centres like Esztergom and Dunaújváros); 4. Axis-based Development Scenario; 5. Diverse Polycentric Scenario (Budapest Metropolitan Region), where the last scenario represents the most complex approach. This scenario aims to create a regional economic hub similar to the Ruhr area in Germany, potentially providing the best support for implementing smart developments.[74]

Budapest's smart city strategy supports sustainability and the enhancement of quality of life, applying a complex, system-wide approach. In addition, it emphasises social inclusion and collaborative planning with various stakeholders, which can improve the widespread adoption of the smart city concept. At the same time, the city's strategy takes into account the alignment with higher-level goals and collaboration with surrounding cities and municipalities. The next section will focus on evaluating the city's current situation based on various city rankings, followed by an analysis of anticipated future developments in the final section.

[71] Gauder et al. 2011: 10.
[72] ESPON 2005: 3.
[73] Gauder et al. 2011: 21; Urban Development Department of the Budapest Metropolitan Government 2014: 31.
[74] Gauder et al. 2011: 29.

3. Budapest's position as a smart city among East-Central European capitals and in global smart city rankings

Before positioning Budapest as a smart city, it is important to evaluate its place within the urban hierarchy using several socio-economic indicators *(Table 3).* These indicators will establish its current standing and help predict its future ranking among smart cities. Essentially, these metrics provide a forecast of Budapest's potential to become a leading smart city.

In the analysis, I have assessed Budapest's position relative to other Eastern and Central European capitals (Prague, Bratislava, Warsaw, Bucharest, Sofia, Zagreb, and Ljubljana) based on key factors such as population, GDP per capita, R&D expenditures, and business density. This comparison helps to understand Budapest's current status and its capacity for future smart city development.

Table 3: Socio-economic data for the metropolitan regions (2019)

	Population (million people)	GDP per capita (euros) as a % of EU27 average)	Number of patents per 100,000 inhabitants	Number of active businesses per 1,000 inhabitants
Bratislava	0.43	127	1.3	277.6
Prague	1.32	105	4.2	325.3
Ljubljana	0.28	104	15.5	n. d.
Warsaw	1.77	98	5.3	185.1
Bucharest	2.13	85	1.5	80.7
Budapest	1.75	73	6.5	186.7
Zagreb	0.81	64	0.2	81.7
Sofia	1.24	55	n. d.	114.5

Source: compiled by the author based on Eurostat data

The above data suggest that Budapest's position is consistently around 3rd to 4th place in most indicators, except for GDP per capita. In terms of population, it is the 3rd most populous Eastern and Central European capital, following Bucharest and Warsaw (with only a slight lag behind Warsaw). However, in GDP per capita, the capital ranks only 6th among capitals, with a value reaching 73% of the EU average. Its position is favourable in terms of the number of patents per capita and the presence of active businesses. In patents, it is 2nd after Ljubljana, while in active businesses, it is 3rd, just behind Prague and Bratislava, slightly ahead of the Polish capital. Based on this, it is likely that the city's performance in smart city rankings would be around this position as well.

3.1. Ranking methods and urban competitiveness analyses

As a first step, I determined the position of the Hungarian capital based on various city ranking methods (rankings by research institutions and organisations) and city competitiveness analyses. This approach falls into the category of less complex, yet generally multi-dimensional measurements. The first ranking represents one of the European

Union's classifications/approaches to categorising smart cities, focusing mainly on their intelligent and sustainable attributes.

In 2014, the European Parliament analysed a total of 599 European cities based on their smart attributes and examined, which dimensions of smart cities dominate in their cases. The analysis included a total of 6 pillars, following the example set by Giffinger and his co-authors.[75] Among the examined cities, a total of 67 cities (11% of the entire list) had, for example, a prominent feature in the smart economy dimension. This was the second least popular after the 'people' pillar (52 cities), whereas the most popular environmental pillar concentrated 33% of the entire list. It is noteworthy that the maturity of smart cities (characterised by the complexity of their components) varies depending on city size (population). This means that the average number of smart city pillars also decreases with a decrease in city size. A city with a population of over 500,000 typically has more than 3.5 features simultaneously, while a smaller city (with a population between 100,000 and 199,000) has only 1.9 dominant components. At the time of the analysis, Budapest was a member of a cluster similar to other cities in Eastern and Central Europe, where the number of smart city initiatives was low and the number of components was still small. Three pillars were more prominently present in the Hungarian capital: mobility, environment, and people. Two projects were identified for Budapest during this period that were in the implementation phase and could contribute to the city's smart concept: the TIDE (Transport Innovation Deployment for Europe) project and the NICE (Networking Intelligent Cities for Energy Efficiency) project. Both projects were carried out through a major European co-operation effort. The TIDE project aimed to introduce innovative urban transport and mobility measures across Europe, primarily along the transport and environment pillars. The NICE project aimed to establish ICT partnerships and enhance energy efficiency among cities.[76] The TIDE project was implemented between 2012 and 2015 with 12 participants and over EUR 2.5 million in funding, focusing mainly on activities such as energy efficiency, decarbonisation, transport safety, and electric vehicles in transport. During this period, co-ordination of Budapest's suburban transport began, and the city was also a key participant in the working group named 'Innovative Concepts for Optimizing Public Transport Organization and Performance'.[77] The NICE project took place between 2011 and 2014 and focused on energy efficiency growth driven by digital technologies in the spirit of the EU Green Digital Charter. Budapest was involved in this phase through the GuiDanCe project component, which supported the co-ordination of city activities through the Green Digital Charter.[78]

In the studies by Kollar and his co-authors, the performance of NUTS3-level (county-level) regions was analysed based on the 6 components developed by Giffinger and co-authors. The following observations can be made for the capitals of Eastern and Central Europe:[79] The smart performance of regions varies considerably across countries. In the

[75] Giffinger et al. 2007: 12.
[76] European Parliament 2014: 65.
[77] European Commission 2015.
[78] European Commission 2014.
[79] Kollar et al. 2018: 23; Giffinger et al. 2007: 12.

economic pillar, the metropolitan regions most often achieved the highest positions within their countries, reflecting the concentration of economic activities in the Eastern and Central European region. In the smart environment pillar, the prominence of metropolitan regions is not clear-cut, with Polish regions performing particularly poorly compared to the overall ranking. In the governance pillar, Czech regions perform relatively poorly compared to their performance in the other pillars, while Polish regions have a relatively favourable position. In terms of smart living conditions, the Czech, Slovenian, and Slovakian regions perform the best. The outstanding performance of capitals based on all components is most favourable in Romania and Poland. In the social pillar, a strong concentration in the capital cities is observed in most countries.[80] The analysis presents results and regional positions from two perspectives: 1. a comprehensive comparison across Europe; and 2. a focus on Southeastern, Central and Eastern Europe (in addition to the Baltic states). In the overall European comparison, the metropolitan region of Budapest ranks approximately around the 1,000th position out of 1,337 NUTS3 regions, similar to Warsaw and Bratislava, while Prague and Ljubljana are ranked more favourably (between the 800th and 900th). Budapest ranks lowest in the European rankings in governance, living conditions, and environmental factors, but is fourth based on the economic pillar, following Prague, Bratislava, and Ljubljana. In the context of Central, Eastern, and Southeastern Europe, the Budapest region is around the 35th position, clustered with Warsaw. Within the region, the economic, living conditions, and transport pillars stand out prominently. The Sustainable Development Solutions Network (SDSN) and the Brabant Centre for Sustainable Development (Telos) have prepared a comparison of the performance of capitals and some major metropolitan areas in the European Union and EFTA (European Free Trade Association) against the United Nations Sustainable Development Goals (SDGs, 17 goals). This is a specialised version of city comparisons, focusing primarily on the environmental and economic dimensions of smart cities. In the initial prototype version, results were presented for a total of 45 European cities using 56 indicators. Oslo leads with a score of 74.8, indicating that it achieves 74.8% of the Sustainable Development Goals (SDGs) according to the metrics used in the index.[81] Budapest was also included in the analysis, and ranks 37th among the 45 European cities surveyed, with a composite score of 55.4. In terms of sustainability dimensions, Budapest still faces significant challenges in five areas, while issues are also notably present in seven other areas. For two dimensions (clean drinking water and reduced inequalities), there is only a minor shortfall compared to the set goals (data for one dimension is incomplete).[82] With this score, Budapest ranks 6th in the East-Central European region, ahead of Bucharest and Sofia.

The Global Urban Competitiveness Report was produced by the Chinese Academy of Social Sciences (CASS) and UN-Habitat, focusing on sustainable urban competitiveness.[83]

[80] Kollar et al. 2018: 25–28.
[81] Lafortune et al. 2019: 13.
[82] Lafortune et al. 2019: 33.
[83] UN 2020: 1.

Since 2015, over 1,000 cities worldwide have been ranked based on economic and sustainability competitiveness. The report creates five city clusters with distinct characteristics based on city connectivity and economic competitiveness. The first group includes global cities (A), the second group comprises international hub cities (B), the third group consists of international gateway cities (C), the fourth group features regional hub cities (D), and the fifth group represents regional gateway cities (E).[84] The most significant performance is observed in clusters A and B, where all analysed dimensions exhibit outstanding performance. The complete ranking includes the composite results of economic and sustainable competitiveness, categorising the analysed cities into the above-mentioned clusters. In contrast, the economic competitiveness ranking only provides a list of cities in order. The placement of the capitals of Eastern and Central European countries is presented in *Table 4.*

Table 4: Position of ECE capitals in the global urban competitiveness ranking and its economic competitiveness pillar (2019–2020)

Ranking of ECE cities in the Global Urban Competitiveness ranking		**Position of ECE cities in the economic competitiveness pillar**	
city	cluster	city	ranking
Warsaw	C+	Bucharest	182
Prague	C+	Warsaw	193
Budapest	C+		
Sofia	C		
Zagreb	C		
Bucharest	C		

Source: compiled by the author based on UN 2020

Note: The ranking of cities in the Global Urban Competitiveness ranking column reflects their strong or weak positions. Ljubljana and Bratislava were not included in the analysis.

Among European cities, London and Paris belong to the so-called global cities group (classified as A+ and A), while Dublin, Vienna, and Brussels also hold prominent positions within category B. Among the capitals of Eastern and Central Europe, two clusters can be identified: Warsaw, Prague, and Budapest are in the higher competitiveness group of 'international gateway cities', while Sofia, Zagreb, and Bucharest face competitive disadvantages.

In the economic competitiveness pillar, which assesses a city's ability to create higher value and maximise services for its residents through internal organisational efficiency and external economic advantages in the processes of co-operation, competition, and development, London (2nd) and Munich (8th) are part of the global Top 10 list, while Dublin is in the Top 20 (14th).[85] From the Eastern and Central European region, two

[84] UN 2020: 12.
[85] UN 2020: 23.

cities are ranked on the list: Bucharest and Warsaw are both included, positioned in the last third of the ranking.

When considering both factors combined, it can be established that there is only a slight correlation between the positions held by the Eastern and Central European region in the overall ranking and its economic competitiveness. However, the Hungarian capital is in a promising position; as an international gateway city, it could play a significant role in the region's economic processes (such as transport corridors, trade, and capital flow) and could become a key centre of gravity in the region, as suggested by the Budapest Metropolitan Region's regional development strategy.

3.2. Multi-factor rankings

As the second step in positioning, I review complex smart city rankings (which are prepared in a comprehensive structure involving numerous indicators, expert opinions, and interviews) analysing Budapest's situation, where I also examine the stronger and weaker components of the city in comparison to the surrounding capitals.

In 2017, IMD (World Competitiveness Center) and Singapore University of Technology and Design (SUTD) decided to create a smart city index that focuses both on the economic and technological aspects of smart cities and their 'human dimension' (quality of life, environment, and inclusivity). Their smart city index was most recently published in 2021 and ranks the world's 118 smartest cities. The list measures residents' opinions on the structures available in their city (such as linear and human infrastructure) and technological applications.[86] At the top of the overall ranking is Singapore, followed by Helsinki and Zurich. The scores for the relevant priority axes and technological conditions are determined based on the opinions of experts and 120 surveyed residents in each city. The final scores for each city are calculated using data from the last three years of the survey, incorporating the residents' assessments. The infrastructure pillar queries the existing infrastructure of the cities, while the technology pillar addresses residents' expectations regarding technological provision and services. Each pillar is evaluated across five key areas: health and safety, transport, activities, opportunities, and governance.[87] The surveys mainly focus on topics related to satisfaction: how satisfied residents are with the quality of public transport in the city, the accessibility of public spaces, the quality of healthcare, etc. The results of the surveys are presented on a scale from 0 to 100, where 100 represents the best position and 0 the worst. The data for the last three years are illustrated in the following table, which includes both the top-performing cities and the capitals of the ECE region.

[86] IMD 2021: 13.
[87] IMD 2021: 5.

Table 5: Position of ECE capitals in the IMD Smart City Index (2019–2021)

	2019		2020		2021
1	Singapore	1	Singapore	1	Singapore
2	Zurich	2	Helsinki	2	Zurich
3	Oslo	3	Zurich	3	Oslo
4	Geneva	4	Auckland	4	Taiwan
5	Copenhagen	5	Oslo	5	Lausanne
…		…		…	
19	*Prague*	*44*	*Prague*	75	Warsaw
61	Warsaw	55	Warsaw	78	Prague
83	**Budapest**	76	Bratislava	96	Bratislava
84	Bratislava	**77**	**Budapest**	**97**	**Budapest**
85	Bucharest	87	Bucharest	106	Bucharest
89	Sofia	89	Sofia	107	Sofia
sum	102	sum	109	sum	118

Source: compiled by the author

Note: The italicised notation indicates results above the top 50%. Ljubljana and Zagreb were not included in the analysis.

Between 2019 and 2021, the IMD Smart City Index saw transformations among the top performers and within the Eastern and Central European region, although Singapore's leading position remained unshaken despite the challenges posed by Covid–19. Additionally, Zurich and Oslo also maintained their stable presence among the top five cities. Among the capital cities of the region, the ranking of settlements remained relatively constant, with two exceptions: a) Ljubljana and Zagreb are not included in the smart cities examined by the IMD, and b) the analysis of the actual situation of the cities is complicated by the fact that the number of cities included in the study varies annually. For the remaining six cities, Budapest fell one position in the rankings after 2020, although this merely indicates a position swap, as Budapest's performance each year moves in line with Bratislava's relevant indicator. Another shift in the region was the movement of Warsaw and Prague, with Warsaw becoming the best Eastern and Central European capital by 2021. In terms of ranking, Prague was in the top 50% of all examined cities in 2019 and 2020, but by 2021, it experienced a loss of position in the entire Eastern and Central European region, with no capitals remaining within the top 50%. In the region, there is a strong emphasis on evaluating human factors (labour market services and job creation), which have been further reinforced due to external shocks in recent times. Changes in the smart city rankings among leading cities highlight that different city management models operate differently during crises, particularly in terms of short-term and long-term effectiveness. In the short term, cities applying bottom-up management (Amsterdam, Helsinki) responded better, but lost ground in the long term, while the top-down strategy proved to be a more effective solution for crisis management in the long term. This is less pronounced among the capitals of the Eastern and Central European region, as most strategies are based on a top-down approach (with only a limited application of social involvement), but changes are still observable here. With the exception of Prague, all

cities improved their relative positions slightly by 2020, which was followed by a more significant decline in 2021 across all cities.

The IESE Cities in Motion Index is prepared annually by the Business School of the University of Navarra and is another well-known example of smart city rankings. The current (2020) version of the index ranks 174 cities based on 9 dimensions and 101 indicators. The main dimensions are human capital, social cohesion, economy, governance, environment, mobility and transport, urban planning, technology, and international profile.[88] The overall index is led by London, followed by New York and Paris, highlighting the exceptional performance of global cities in this ranking *(Table 6).* Among the top-performing European cities, 6 appear in the global top 10, with an additional 4 in the top 20.

Table 6: Position of ECE capitals in the IESE Cities in Motion Index (2014–2020)

	2014		**2015**		**2016**		**2017**		**2018**		**2019**		**2020**
1	Tokyo	1	London	1	New York	1	New York	1	New York	1	London	1	London
2	London	2	New York	2	London	2	London	2	London	2	New York	2	New York
3	New York	3	Seoul	3	Paris	3	Paris	3	Paris	3	Amster-dam	3	Paris
4	Zurich	4	Paris	4	San Francisco	4	Boston	4	Tokyo	4	Paris	4	Tokyo
5	Paris	5	Amster-dam	5	Boston	5	San Francisco	5	Rejkjavík	5	Rejkjavík	5	Rejkjavík
…		…		…		…		…		…		…	
65	Prague	56	Prague	45	Prague	41	Prague	40	Prague	47	Prague	39	Prague
74	**Budapest**	**65**	**Budapest**	**68**	**Budapest**	54	Warsaw	**53**	**Budapest**	69	Warsaw	54	Warsaw
76	Warsaw	72	Warsaw	74	Warsaw	**67**	**Budapest**	64	Warsaw	70	Bratislava	62	Bratislava
86	Ljubljana	85	Sofia	83	Bratislava	70	Ljubljana	67	Bratislava	**73**	**Budapest**	**74**	**Budapest**
90	Sofia	87	Ljubljana	86	Ljubljana	77	Bratislava	74	Ljubljana	93	Ljubljana	98	Zagreb
n. a.	Bratislava	n. a.	Bratislava	95	Sofia	84	Zagreb	83	Zagreb	97	Zagreb	99	Ljubljana
n. a.	Bucharest	n. a.	Bucharest	107	Zagreb	91	Sofia	101	Sofia	103	Bucharest	103	Bucharest
n. a.	Zagreb	n. a.	Zagreb	110	Bucharest	109	Bucharest	n. a.	Bucharest	115	Sofia	116	Sofia
∑	135	∑	148	∑	181	∑	180	∑	165	∑	174	∑	174

Source: compiled by the author

The position of cities in the Eastern and Central European region has varied significantly in terms of rankings since 2014. At the same time, the total number of cities examined has also shown considerable growth over the period. Budapest's position was stable until 2018, usually ranking 2nd after Prague, but it fell to 4th place from 2019 onwards, being surpassed by Warsaw and Bratislava. Similarly to the IMD studies, Bucharest

[88] IESE 2020: 13.

and Sofia are the laggards here as well, and while the order of cities differs, Budapest is still ranked 4th among the cities examined. In the region, Prague's position can be considered exceptionally strong, with its ranking continuously improving despite the increasing number of cities being evaluated. Budapest has also seen improvement but at a slower pace compared to Prague or Bratislava. When analysing individual components, Warsaw and Bratislava each have a pillar that is in the global top 10: in Warsaw, it is the governance pillar, while in Bratislava, it is the social cohesion factor. According to the most recent data, Budapest's strongest pillars are transport (31st place), human capital (34th place), and international outlook (39th place). However, the index highlights deficiencies in 'hard' factors, as the city ranks only 135th in the economic component, which measures indicators such as GDP, R&D, innovation, and corporate presence. This is not only one of the weakest areas for Budapest but also for all capitals in the region.

The European Commission periodically examines the quality of life in European cities through the 'Quality of Life in European Cities' report, typically every two to three years. Since one of the main goals of creating smart cities, according to many definitions, is to enhance the quality of life for residents, it is valuable to consider the population's perspective on the state of their cities. The most recent report, from 2019, covers 83 cities in the EU, EFTA, the United Kingdom, the Western Balkans, and Turkey. The survey reveals which cities have residents most satisfied with the quality of public and other services. A total of 700 interviews were conducted in the cities examined. Among EU cities, the highest satisfaction is found in the northern and western parts of the continent, with average satisfaction levels around 94% and 92%, respectively, while cities in the southern member states are in the worst positions. An interesting finding is that as city size decreases, resident satisfaction with their living environment increases, meaning that smaller cities are generally more liveable.[89] The analysis examines several dimensions of satisfaction within cities. *Table 7* illustrates the overall satisfaction with the city for the capitals in Eastern and Central Europe, including shifts compared to the year 2015.

Table 7: Residents' satisfaction with their city in the ECE capitals

Complex satisfaction with the city (%), 2015		Complex satisfaction with the city (%), 2019	
Prague	91	Prague	92.6
Budapest	**90**	**Budapest**	**86.2**
Warsaw	93	Warsaw	92.3
Ljubljana	92	Sofia	83.1
Sofia	86	Ljubljana	93.5
Bratislava	90	Bratislava	92.5
Bucharest	83	Bucharest	81.6
Zagreb	94	Zagreb	90.2

Source: compiled by the author

[89] Bolsi et al. 2020.

Based on the aggregate data, it can be inferred from the table that, with the exception of Prague, Bratislava, and Ljubljana, there has been a decline in overall satisfaction with cities, including a 3.8 percentage point decrease in Budapest. It is also noteworthy that there is a correlation between city population size and the quality of life for residents in Eastern and Central Europe. An analysis of the numbers reveals a moderately strong negative correlation between city population size and overall satisfaction. In other words, among the capitals in the region, cities with smaller populations tend to be perceived as more liveable by their residents.

In addition to satisfaction, the survey also inquired whether people consider their city to be a good place to live in general, beyond their personal situation. The survey found a positive correlation (around 0.6) between those who are completely satisfied with their city and those who agree that their city is generally a good place for people.

The correlation among the capitals of Eastern and Central Europe is also moderately strong (around 0.5, lower than the overall European city list) and positive between the two factors *(Figure 5),* with its distribution roughly reflecting results from other rankings. Prague leads in both dimensions, while Bratislava and Warsaw also have favourable positions. However, unlike most previous analyses, Budapest shows more similarity to Bucharest and Sofia.

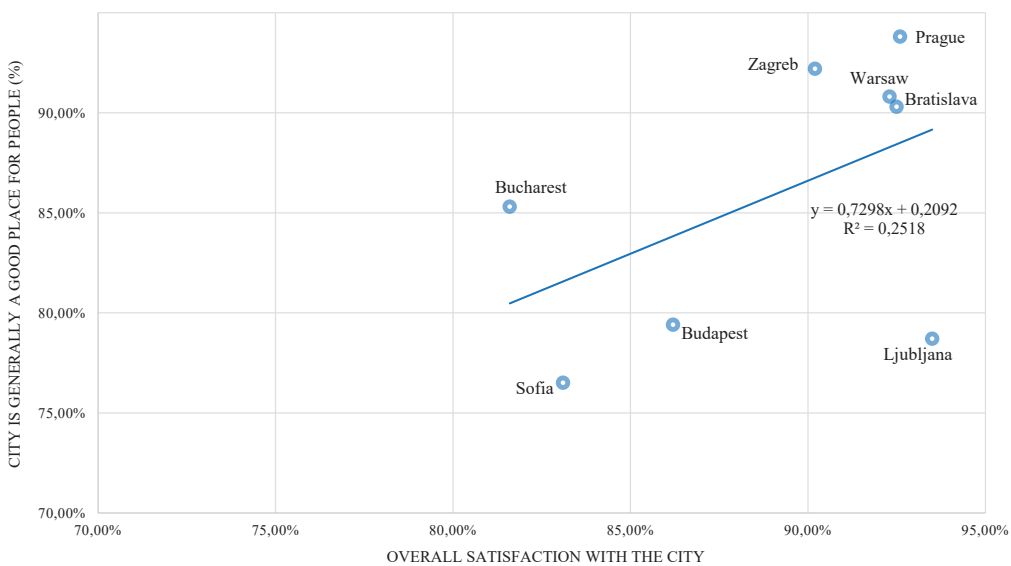

Figure 5: Correlation between complex satisfaction in Eastern and Central European capitals and overall perception of the city

Source: compiled by the author based on data from European Commission 2020

In the 2019 survey, people were also asked how the quality of life in their own city had changed compared to five years ago, with the following response options: a) quality of life has increased; b) decreased; or c) remained unchanged. On average, 38% of respondents across all cities reported that the quality of life in their city had improved over the past five years. The perceived quality of life increased most in cities of Eastern EU member states, averaging 53%, followed by cities in Northern EU countries (43%). Among capital cities within the Eastern and Central European region, the picture is heterogeneous: while 59.3% of respondents in Sofia and 53.1% in Prague believe that the quality of life has improved over the past five years, only 39.6% in Budapest and 26.9% in Zagreb hold this view.[90]

Among the indicators examined in the analysis, Budapest outperformed the average of the 83 cities in four areas (accessibility of online public services, cultural services, quality of public spaces, and use of public transport), while performing at the average level in three areas (satisfaction with the quality of public transport, affordability of public transport, and accessibility of job opportunities). However, there are two components where Budapest falls short by 15 percentage points or more compared to the city average (liveability for families with young children, quality of healthcare). Based on the number of factors where Budapest performs above average, it shows similarities with Bratislava, Bucharest, and Sofia in this ranking.

The following is a comparison of the three methodologies described above, focusing on how similarly the capitals of the region perform across various pillars. According to the IMD Smart City index, the various dimensions of the currently available structures are examined, focusing on the three components with the highest ratings. Among the cities reviewed, the accessibility of cultural services stands out as the most notable component, with ratings exceeding 65%. Budapest scores 72.7% in this category, making it the third highest after Prague and Warsaw, except for Bratislava, where the education of children receives the highest rating. Additionally, the accessibility of labour market services is a top 3 factor in four cities, while business job creation services are a top 3 factor in three cities. Besides cultural services, Budapest also received good ratings in the above two components (63.5% and 61.3%, respectively). At the same time, it is clear that the performance of the capitals in the ECE region shows significant deviations in structural factors compared to leading European smart cities, both in terms of outstanding components (e.g. healthcare, education, lifelong learning) and in the strength of the ratings (higher scores). The summary of the three methodologies is presented in *Table 8.*

[90] Bolsi 2020: 17.

Table 8: Comparison of the positions of the ECE region's capitals according to three main rankings

IMD Smart City index	IESE Cities in Motion index	Quality of life in the European Cities Survey
Common characteristics of the ECE cities		
Availability of cultural services is outstanding (over 65%) – strongest component in all cities except Bratislava. Availability of labour market services is in the top 3 for four cities Business job-creating services are in the top 3 for three cities.	Social cohesion is among the top 3 components in 6 out of 8 cities, while governance is among the top 3 in 4 cities. The environment and human capital pillars are also in a strong position.	Emphasis on affordable and accessible public transport. Significance of cultural elements/ services.
Specificities		
In the case of Bratislava, the highest-rated aspect is the education level of children. Differences of the ECE region compared to leading smart cities in Europe (!) – other outstanding components (e.g. healthcare) have stronger scores.	Unique characteristics of Budapest: high emphasis on transport, human capital, and international relations – social cohesion is not in the top 3. Warsaw and Bratislava each have a component in the international top 10.	Unique aspect for Prague is liveability, while for Ljubljana it is the quality of green spaces. In Budapest and Zagreb, the quality of public spaces is also excellent.
The strengths of the ECE smart cities are similar based on the three metrics, although they exhibit distinct characteristics compared to the leading cities. They show a strong focus on cultural centrality and an emphasis on social (soft) factors.		

Source: compiled by the author

In the IESE Cities in the Motion index, the capitals of Eastern and Central Europe also show similarities in various aspects (social cohesion is among the top 3 components in 6 out of 8 cities, and governance is in the top 3 for 4 cities). However, there is considerable variation in the rankings for individual factors. For instance, as noted in the detailed analysis of the index, Warsaw and Bratislava have components that rank in the top 10 internationally: Warsaw's governance pillar is 8th among 174 cities analysed, while Bratislava is 9th for social cohesion. Budapest, in contrast, differs somewhat from other Eastern and Central European capitals in this index. It shows the strongest values in transport, human capital, and international relations (ranked 31st, 34th, and 39th respectively). However, social cohesion in Budapest does not rank in the top 3, unlike most other cities, and the economic component is notably low at 135th place, which is the third-worst after Sofia and Ljubljana.

The 'Quality of Life in European Cities Survey' highlights two main pillars in the capitals of the region. Similar to the IMD index, it underscores the significance of cultural services and the significant attention given to affordable and accessible public transport across all cities, with a broad level of satisfaction among the population. A unique feature for Prague is its liveability, while Ljubljana stands out for the quality of its green spaces (which is not surprising given its former status as 'European Green Capital').[91] In Budapest, the quality of public spaces and online administrative services are also noted as excellent.

[91] Cömertler 2017: 5–7.

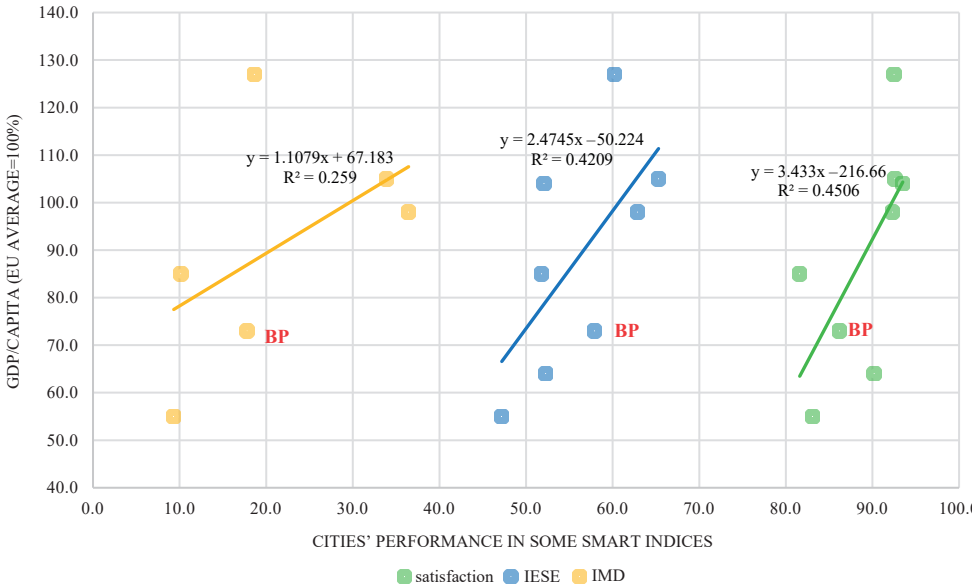

Figure 6: Correlation between cities' smart performance and GDP per capita, 2019–2020
Source: compiled by the author

A comparison of the methods reveals that the capitals of the ECE region share similarities in strengths across all three metrics, however, they have distinct characteristics and emphasis compared to leading cities. A common point in the cities of the region (including Budapest) is that they tend to be stronger in soft factors (e.g. strong cultural centrality, social factors, and matters related to population satisfaction), whereas they lag behind in hard indicators compared to the leading cities (e.g. the IESE economic dimension with factors such as R&D, GDP, investments).

The performance of the cities in various smart indexes shows a positive correlation with the per capita GDP values. This suggests that areas with more developed economic indicators and functional urban regions are likely further along the path to becoming smart cities, as reflected in their higher rankings *(Figure 6).*

The linear trend, based on data from the IESE Cities in Motion Index and the Urban Audit Perception Survey, shows a fit of over 40%, indicating a relatively strong alignment. This suggests a good correlation, whereas the IMD Smart City Index demonstrates a less pronounced relationship. Kollar and colleagues' study supports a close link between smart city indexes and per capita GDP (i.e. smart cities and economic development) in European NUTS3 regions. The smart region index scores exhibited a strong and positive relationship with GDP measured in purchasing power parity per capita. Additionally, researchers observed a positive correlation across all pillars.[92] However, there was variation in this

[92] Kollar et al. 2018: 24.

regard, as in many regions, only a slight improvement in the smart region pillars was observed relative to GDP levels, while others showed that a high level of smartness does not necessarily translate into economic performance. Therefore, these studies can help assess which aspects are the strongest and which areas require development.

4. Expected changes in Budapest's position in the region

The results seen in various rankings have highlighted that, within the broader Eastern and Central European region, Budapest typically ranks around 3rd or 4th among the capitals. In dimensions related to satisfaction and soft elements, Budapest's position is occasionally even better. According to most multi-dimensional analyses that aggregate numerous indicators, the environmental–sustainability pillar, as well as indicators related to public transport and cultural services (quality of life), reflect the most promising values. Therefore, it is worthwhile to compare some indicators in these dimensions from the perspective of the population as well. Since the majority of the previously discussed rankings (with the exception of the Urban Audit) were based on quantitative statistical indicators, the population's opinions on the achieved improvements and the smart status of the cities may differ. My aim was to identify changes and make possible predictions based on average shifts, so I examined the indicators over several years (2012, 2015, and 2019). I have analysed three main indicators as an extension of the ranking results, with the following content and indicators:

- Complex environmental satisfaction (high satisfaction with urban green spaces;[93] high satisfaction with air quality in the city; high satisfaction with living in the city among respondents; high satisfaction with urban noise levels)
- Satisfaction with public transport (high satisfaction with public transport: bus, metro, tram)
- Satisfaction with cultural services/quality of life (high satisfaction with sports facilities, such as sports fields and indoor sports halls; high satisfaction with cultural facilities [concert halls, museums, cinemas]; strong overall satisfaction with urban quality of life; high satisfaction with public spaces, markets, and pedestrian areas)

The study was assisted by the Eurostat Urban Audit Perception Survey. The Urban Audit Perception Survey includes a total of 278 indicators measured on qualitative scales and supports qualitative research. The survey uses a five-point Likert scale for the indicators, with respondents categorised as follows (1 – very satisfied, 2 – somewhat satisfied, 3 – somewhat dissatisfied, 4 – dissatisfied, 5 – does not know/did not answer). Since the scaling and units of the indicators were consistent, no further transformation was needed during the calculations. Thus, based on the aggregation of the indicators and the average trend-based forecasts, the following conclusions can be drawn.

[93] More than 80% of the population is highly satisfied.

Regarding complex environmental satisfaction, Ljubljana leads the ranking in all three years ahead of Zagreb, followed by Warsaw and Prague *(Table 9).* However, while Prague's position is improving, Warsaw is losing ground. Budapest ranked 6th in 2012 and then 5th in 2015 and 2019, surpassing Bratislava with rapidly increasing values. Its average growth rate during the period reviewed is the highest, at 13.5%, alongside Prague.

Table 9: Development of the complex environmental satisfaction index in the capitals of the ECE region (2012, 2015, and 2019) and expected change for 2024

	2012	2015	2019	2024 estimated
Ljubljana	39.0	43.5	42.3	44.1
Zagreb	30.8	36.0	37.7	41.7
Prague	20.8	24.3	27.1	31.0
Warsaw	26.0	25.3	24.6	24.0
Budapest	18.5	21.0	23.9	27.1
Bratislava	19.0	18.3	19.9	20.4
Bucharest	16.0	17.0	17.6	18.5
Sofia	17.0	16.8	16.4	16.1

Source: compiled by the author

Assuming the continuation of the previous trend (with all other factors remaining constant), it is expected that by 2024, Budapest will improve its position in environmental satisfaction, supporting the success of recent developments, and surpass the Polish capital, which has shown declining performance since 2012. No changes are anticipated in the ranking of other cities.

In terms of public transportation satisfaction, based on residents' opinions, Prague has led the ranking since 2015 (due to the decline of the previously leading Ljubljana), ahead of Ljubljana and Zagreb. Budapest also shows significant improvement in this indicator and is already 5th on the list by 2019 *(Table 10).* Its average annual satisfaction growth rate is the highest in the entire region (over 30%).

Table 10: Development of satisfaction with public transport in the capitals of the ECE region (2012, 2015 and 2019) and expected change for 2024

	2012	2015	2019	2024 estimated
Prague	35.0	42.0	42.2	46.5
Ljubljana	41.0	31.0	32.9	30.2
Zagreb	22.0	29.0	30.2	35.6
Warsaw	29.0	24.0	25.8	24.6
Budapest	11.0	16.0	18.7	24.5
Sofia	19.0	18.0	17.2	16.4
Bratislava	10.0	11.0	16.1	18.2
Bucharest	9.0	6.0	7.2	6.7

Source: compiled by the author

The projected changes indicate that Budapest will remain in the 5th place, but the forecast shows a significant reduction in its gap, bringing it closer to the Polish capital, while significantly pulling ahead of Bratislava, which follows. There will also be several shifts in the region, as Ljubljana continues to lose ground and Zagreb could become the 2nd place holder by 2024. Additionally, Bratislava is expected to move up one place on the list.

In the dimension related to cultural services and quality of life, Ljubljana has the highest values throughout the entire period, with a significant advantage over Prague and Zagreb *(Table 11).* Since 2015, Budapest has been 4th among the capitals, surpassing Warsaw, and its average growth rate in this category is also the highest (9.2%).

Table 11: Development of satisfaction with cultural services/quality of life in the capitals of the ECE region (2012, 2015 and 2019) and expected change for 2024

	2012	2015	2019	2024 estimated
Ljubljana	46.8	47.0	47.2	47.3
Prague	34.5	37.0	38.6	40.8
Zagreb	31.5	35.3	37.4	40.8
Budapest	25.3	28.5	30.1	32.9
Warsaw	28.5	27.0	27.6	27.2
Bratislava	21.3	20.5	22.2	22.6
Bucharest	18.5	20.0	19.9	20.6
Sofia	19.3	18.5	19.4	19.4

Source: compiled by the author

The forecast indicates that the ranking of cities will remain unchanged in 2024, with each city maintaining its position. However, Budapest is expected to further stabilise its fourth place and increase its lead over Warsaw.

Overall, based on the forecasts, it can be stated that further improvement in the above-mentioned three indicators could represent a significant breakthrough for the capital, potentially enhancing its position among smart cities in the region.

Summary

Since the 1990s, the term ‘smart cities’ has been widely used to refer to successful regions utilising digital technologies and the outcomes of Industry 4.0. However, a unified definition remains elusive. Definitions vary widely, ranging from ICT-based approaches to more complex definitions incorporating soft factors. Budapest’s smart city strategy was developed in 2019, focusing primarily on sustainability and liveability, aiming to achieve these goals through the opportunities provided by digital technologies. The strategy is predominantly top-down in approach but also highlights the significance of social engagement in several aspects (district strategies, living labs, project generation processes). Its territorial integration is reinforced by the presence of smart strategies in several districts and its reliance on the broader metropolitan area.

Among the capital cities of the broader Eastern and Central European region (Prague, Bratislava, Warsaw, Bucharest, Sofia, Zagreb, Ljubljana), Budapest's position fluctuates around 3rd to 4th place in key socio-economic indicators, except for GDP per capita. Methods ranking smart cities and urban competitiveness studies highlight various strengths: the European Parliament's investigations focus on mobility, environment, and people; the European Investment Bank's report suggests that Budapest's regional position is comparable to Warsaw and Bratislava, whereas Prague and Ljubljana have more favourable standings; according to the Global City Competitiveness Ranking, Warsaw, Prague, and Budapest form a relatively high-competitiveness 'international gateway city' trio. Nonetheless, Budapest ranks only 6th in terms of SDG indicators, ahead of Bucharest and Sofia.

In rankings based on multiple factors, Budapest's performance in the IMD studies is aligned with Bratislava's relevant indicators (thanks to its strong human factors [labour market services, job creation]), while in the IESE index, Budapest has been in 4th place since 2019, following Prague, Warsaw, and Bratislava. The most favourable aspects are transportation and human capital, although in terms of hard factors (economic components), Budapest is in the lower third of the list. In ECE capitals, including Budapest, the observation holds true that cities with lower populations tend to appear more liveable according to residents' opinions. A common feature among the region's cities (including Budapest) is their relative strength in soft factors (such as a strong cultural centricity, social factors, and questions related to resident satisfaction), while they generally face greater disadvantages in hard indicator components compared to leading cities.

Forecasts suggest that the Hungarian capital's satisfaction indicators may improve further due to ongoing developments. For instance, Budapest may surpass the Polish capital, which has shown deteriorating performance since 2012 in terms of environmental satisfaction, while maintaining its 4th place among capitals in satisfaction related to public transportation and living conditions/culture, with an accelerating growth rate.

Several factors may have a favourable impact on Budapest's overall position, such as the co-creation approach in district-level strategies, which might improve the social acceptance of these strategies. If district-level living lab projects are successful, developments may be extended to other city areas or the entire city. Enhancing the aforementioned strengths may improve residents' satisfaction with various services, and progress in hard factors may favourably influence its ranking among Eastern and Central European capitals.

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