

Factors of Successful Development of Smart Cities

Kalenyuk Iryna[†], Uninets Iryna^{††}, Panchenko Yevhen^{†††}, Datsenko Nataliia^{††††}, Bohun Maxym^{†††††},

[kalenyuk@ukr.net](mailto:kalenuk@ukr.net), germanirina@gmail.com, d_tashakneu@ukr.net, bohumm@i.ua

[†] Kyiv National Economic University named after Vadym Hetman, Kyiv, Ukraine

^{††} Kyiv National Economic University named after Vadym Hetman, Kyiv, Ukraine

^{†††} Kyiv National Economic University named after Vadym Hetman, Kyiv, Ukraine

^{††††} Kyiv National Economic University named after Vadym Hetman, Kyiv, Ukraine

^{†††††} Cherkasy State Business College, Cherkasy, Ukraine

Summary

The increase in the number of large cities and the size of their population sharpens attention to the new role of cities as entities to ensure a high-quality, safe and modern life of citizens, which has become significantly more active in recent years. The rapid spread of smart cities in the modern world has actualized the issue of analyzing their success and assessing the role of various factors in this. Every success of a smart city is always the result of a unique combination of the most modern technologies, environmental and social initiatives, skillful and consistent management, as well as available human potential. The purpose of the article is to analyze the success factors of smart cities based on the generalization of the results of the most famous ratings. In order to identify the impact of various factors, primarily intellectual, on the success and leadership positions of smart cities, the following ratings were consistently analyzed: Smart City Index (SCI), City in Motion Index (CIMI), Global Power City Index (GPCI), Global Cities Index (GCI), Global Cities Outlook (GCO). They have a different list of indicators and main pillars (dimensions), but all ratings take into account aspects such as: governance, ICT, mobility, functionality, human capital, etc. The highest correlation coefficient, that is, the strongest linear relationship of the CIMI index was found with such factors as: Human capital, Economy, Governance and Technologies. Summarizing the results of the TOP 20 smart cities according to different ratings allowed us to confirm that the list of leaders is very similar in all ratings. Among those cities that are in the TOP-20 in all five indexes are: London, Sydney and Singapore. There are four indices: New York, Paris, Tokyo, Copenhagen, Berlin, Amsterdam, Melbourne. Achieving leadership positions in smart city rankings is always the result of a combination and synergy of certain factors, and first of all, it is the quality of human capital. The intensity and success of the use of information and communication technologies in locality management processes, city planning and improvement of the city's living conditions depend on it.

Keywords: *Smart City; Smart Sustainable City; human capital; technologies; IKT; Smart City Index*

1. Introduction.

The actualization of the problems of the functioning of cities (in the unity of economic, political,

environmental, social and managerial aspects) is connected with the growing importance of the city as a subject of the economy and, in general, of the global economy. Under the influence of the colossal acceleration of the urbanization process, the share of the urban population is steadily growing, and since the second half of the 20th century, at a rapid pace. In general, the share of the urban population in the world has increased from 29.6% in 1950 to 56.2% in 2020, and according to forecasts, it will be 68.4% in 2050 - that is, it will more than double in a century. The annual growth rate of the urban population is on average around 2% in the world, while the growth rate of the rural population is gradually decreasing from 1.8% in the early 1960s to 0 percent in 2020 (World Bank Open Data...). The number of large cities with a population of many millions is increasing: Tokyo - 37.4 million people, Delhi - 29.4 million people, Shanghai - 26.3 million people, Sao Paulo - 21.9 million people, Mexico City - 21.7 million people (World City Population...). The concept of "global city" appeared as the personification of a city that has global significance in various aspects (economic, financial, cultural, etc.).

Increasing attention to the multidisciplinary problems of cities as entities to ensure comfortable and safe living conditions of citizens takes place both in the practical and the theoretical plane. The emergence of the phenomenon of smart cities and their dynamic growth in recent years has significantly intensified analytical research in this direction. Moreover, the practical level of implementation of smart cities is rapidly developing and provides a lot of material for analysis.

The exact number of smart cities is not known, as their progress on this path is very different. There are cities that have achieved significant success in implementing the concept of a smart city, and they are usually included in well-known rankings and known for their ideas. According to various ratings, the number of famous world smart cities includes from 48 to 174 world cities (table 1). Other cities are only implementing

individual initiatives and are just beginning to develop their vision of a "smart city". Each case of a smart city always represents a unique combination of state-of-the-art technologies, environmental and social initiatives, skillful and consistent management, as well as available human potential. The rapid spread of smart cities in the modern world has actualized the issue of analyzing their success and assessing the role of various factors in this.

2. Analysis of recent research and publications

The problems of the formation and development of smart cities are devoted to the research of a significant number of scientists: A. Pozdniakova (Pozdniakova, 2017); Caragliua A. (Caragliua, 2012); L. Galperina; V. Mazurenko (Galperina, 2016); V. Kumar (Kumar, 2012); R. Novotny (Novotny, 2014) and others. The essence, structure, evolution of the phenomenon of smart cities are the subject of research: R. Giffinger (Giffinger, 2007); M. Angelidou (Angelidou, 2016); A. Caragliu (Caragliu, 2011; Caragliu, 2012); M. Eremia (Eremia, 2016).

In the scientific community, not only the specifics of the implementation of the concept of a smart city, but also the study of the key factors of its success are relevant. These issues are explored by P.Lombardi, S.Giordano, H.Farouh & W.Yousef (Lombardi, 2012); Indian researchers S.M. Sureshchandra, J.J.Bhavsar & J.R.Pitroda (Sureshchandra, 2016) thoroughly analyze the scientific publications on this issue and systematize the key success factors of smart cities.

Margarita Angelidou analyzed the 15 most famous smart cities and highlighted their main characteristics: Technology, ICTs and the Internet; Human and Social Capital Development; Promotion of Entrepreneurship; Collaboration and Networking Activities; Privacy and Security; Locally Adapted Strategies; Participatory Approaches; Top-Down Coordination; Explicit Strategic Frameworks; Interdisciplinary Planning (Angelidou, 2017). Ukrainian researcher A. Pozdniakova (Pozdniakova, 2019) also analyzes in detail the models of smart city architecture. In the solid monograph "Smart Cities: Issues and Challenges Mapping Political, Social and Economic Risks and Threats" Edited by A. Visvizi and M. D. Lytras, a large team of authors examines various aspects of the successful functioning of smart cities (Smart Cities: Issues...).

3. The purpose

The purpose of the article is to analyze the success factors of smart cities based on the generalization of the results of the main ratings.

4. Results

In recent decades, many rankings have emerged that attempt to rate smart cities. In general, many of them use a comprehensive approach, which takes into account various aspects of the life of the city. Some ratings are implemented on the basis of objective information and statistical data, some - on the basis of surveys of the population or interested parties, others - combine these approaches. Given that the annual preparation and publication of the rating is a rather troublesome and time-consuming task, not all of them can withstand a long history. A certain barrier is the difficulty in obtaining objective information, and therefore some stop publishing after a couple of years. In addition, the COVID-19 pandemic has become a difficult test for the world, which has seriously affected both the living conditions of people and the ability to collect objective information.

For quite a long time, the problem of assessing living conditions in cities has been relevant in international analytics. Among the most well-known indexes of living conditions in cities are the following: "Quality of Life Survey" (Monocle magazine) (Copenhagen..., 2021); World's Best Cities To Live (Global Finance); "Global Liveability Ranking" (Economist Intelligence Unit) (Global Liveability Index, 2021); "Mercer Quality of Living Survey" (Quality of Life Survey, 2019); Liveability Survey (Deutsche Bank); Numbeo's global database of consumer prices, crime rates, quality of health care and other indicators by city (also based on surveys).

In all of the above-mentioned approaches, a fairly wide range of indicators characterizing living conditions in cities is considered. At the same time, the next stage is the study of the emphasis on smart characteristics. At the moment, we consider the following ratings of the development of smart cities to be the most consistent and informative: Smart City Index (SCI), City in Motion Index (CIMI), Global Power City Index (GPCI), Global Cities Index (GCI), Global Cities Outlook (GCO).

All of them take into account such aspects as: governance, ICT, mobility, functionality, human capital, etc. The list of indicators and main pillars (dimensions) can be very different, but these main aspects remain fundamental in identifying the progress of each city. Although the practice of creating smart cities is extremely

diverse, the key aspects are: increased attention to solving environmental problems, social and cultural communication, ensuring mobility and functionality of the city, new quality of city management with the help of the modest technologies.

The international community has developed a methodology for key performance indicators for smart sustainable cities (Collection methodology for Key Performance Indicators for Smart Sustainable Cities) (Collection methodology,...). This effort is carried out as part of The United for Smart Sustainable Cities (U4SSC) initiative, and its goal is to present a methodology for collecting information on key performance indicators of smart sustainable cities. The proposed set of indicators can be used by cities for self-evaluation and measurement of progress in the direction of: achieving the Sustainable Development Goals (SDGs); become more intelligent, become more sustainable. These Key Performance Indicators can be useful for measuring the city's progress, for comparison with other cities, and for defining a set of standard approaches to achieving the SDGs.

The whole complex consists of a set of indicators in three main dimensions: Economy, Environment and Society and Culture. In turn, the Economy section is divided into: ICT; Productivity; Infrastructure. Environment section on: Environment; Energy. The Society and Culture section consists of two main parts: Education, Health Care and Culture; Security, Housing and Social Inclusion.

Of course, that in its very essence, the success of a smart city is determined by the use of ICT, the quality of human capital and management, and the involvement of citizens in solving issues of shared living. Nevertheless, the problems of finding out what factors make certain cities achieve leadership positions remain interesting. In our opinion, one of the key factors in the success of smart cities is precisely intellectual factors. They can be represented by various indicators, both direct (those that directly testify to a certain level of intellectual resources or achievements), and embodied in other resources. For example, the following can be attributed to direct indicators: the level of education of the population, the share of the population with higher education, the number of universities, the number of researchers, etc. Various approaches take into account such indicators as, for example, the number and quality of higher education institutions (the number of higher education institutions that are among the best universities in the world, the number and quality characteristics of the functioning of world-class research centers, etc.).

Along with this, there are indicators that already testify to the results of intellectual activity: the number of patents, startups, the spread of ICT among the population and business, etc. Undoubtedly, the most important and

indicative are the indicators of technological development, the degree of penetration of ICT into the processes of daily life of the city. In addition, the intellectual component is also an important factor in the quality of management and urban planning.

In our opinion, the selection of the intellectual component in various approaches to the analysis of the success of smart cities and the role in assessing their potential is an interesting and insufficiently researched scientific and practical problem. In order to solve it, those indexes of smart cities that provide enough information for analysis were taken. Generalization and analysis of the results of the main ratings will allow to assess the success of Smart City from the point of view of the influence of intellectual factors.

In the above-mentioned guide on Key Performance Indicators for smart sustainable cities, the following educational indicators are indicated: access of students to ICT (Percentage of students with classroom access to ICT facilities); student contingent of school age (Percentage of school-aged population enrolled in schools); population with higher education (Higher level education degrees per 100,000 inhabitants); adult literacy rate (Adult literacy rate).

In the Economy section, there is a separate subsection "ICT infrastructure", which is characterized by such indicators as: household access to the Internet; fixed broadband access; subscriptions; wireless broadband subscriptions; wireless broadband coverage, availability of WIFI in public areas (Household Internet Access, Fixed Broadband, Subscriptions, Wireless Broadband Subscriptions, Wireless Broadband Coverage, Availability of WIFI in Public Areas) (Collection methodology,...).

The next index - City-in-Motion-Index - was developed by the IESE Business School of the Spanish University of Navarra (University of Navarra) and is calculated on the basis of 10 key dimensions: management, urban planning, public administration, technology, environment, international recognition, social cohesion, mobility and transport, human capital and the economy. In general, the assessment is based on 101 indicators. This index already covers a larger number of cities (2015 - 148, 2016 - 181, 2017 - 180, 2018 - 165, 2019 - 174, 2020 - 174) (IESE Cities in Motion Index...).

The City in Motion Index takes into account the following indicators of human capital: the share of the population with secondary and higher education, the number of public and private schools in the city, the number of business schools in the city (which are included in the TOP-100 according to the Financial Times version); expenditure on education relative to income per capita; annual spending on recreation and wellness relative to income per capita; spending on recreation and

wellness as a percentage of GDP; number of international students; number of museums and art galleries per city; number of universities included in the 500 QS Top Universities; number of theaters per city. In general, out of 101 indicators included in the City in Motion Index, the share of intellectual factors is: 10 indicators in the "Human capital" category and 17 indicators in the "Technology" category.

Kearney Corporation even develops two indexes: Global Cities Index and Global Cities Outlook. In the Global Cities Index, special importance is also attached to intellectual factors. Overall, there are five key imperatives for city leadership: winning the competition for global talent; perception of the rapid growth of the digital economy; ensuring economic stability through the balancing of global and local resources; adaptation to climate change; investing in the well-being of citizens and communities (Global Cities Report ...).

In the Global Cities Index, such an indicator of human capital as the level of education is taken into account. Moreover, 30% of the weight of this index is allocated to human capital. Global Cities Outlook consists of four components, one of which - innovation (25%) - is calculated on the basis of indicators: patents in business, private investments, incubators.

The developers of the Global Cities Index believe that global cities should do everything possible to attract talent from around the world. One detailed study using 35 years of US county data found a positive correlation between immigration and local innovation, economic dynamism, and wages. In fact, half of all engineering and technology startups in Silicon Valley are led by immigrants (Global Cities Report ...). And although the COVID-19 pandemic has had a very serious impact on international mobility in terms of limiting its opportunities, nevertheless, the importance of attracting foreign talent encourages the search for new forms of competition. "In today's competitive environment, cities that can build and create an immigrant-friendly brand with a high quality of life complemented by economic opportunity will win" (Global Cities Report ...).

The 2021 edition of the Global Cities Index presents the most striking examples of successful global city competition. Yes, San Francisco is recognized worldwide as a leading technology epicenter, offering probationary periods for skilled potential immigrants. Helsinki is actively campaigning to show that the city not only has a thriving tech sector, but also offers great amenities and a high quality of life for Finns and expats alike.

In addition to attracting foreign specialists, the integration of immigrants is also actively supported. New York City has one of the most extensive city programs in the United States to support immigrant integration

through the Mayor's Office of Immigrant Affairs (MOIA), which provides English language learning, outreach, and access to a wide range of city services in the city.

Stimulating the "circulation of brains", i.e. the return home of those persons who went abroad for study or work, is also considered an important area of talent attraction. Founded in 2011, the Shenzhen Talented Peacocks program aims to attract international talent, including Chinese and foreign nationals. The three-tiered high-level talent attraction initiative includes financial incentives for world-renowned intellectuals, executives and athletes and aims to attract professors who have taught at world-renowned universities to help develop the local educational and innovation ecosystem. Thanks to its reputation as a city with a welcoming and tolerant urban culture, Shenzhen's attraction program attracted 1,219 highly skilled people in its first five years, only 74 of whom were non-Chinese citizens. This program helped turn the city into the Silicon Valley of China (Global Cities Report ...).

The Global Power City Index (GPCI) is developed by the Institute for Urban Strategies The Mori Memorial Foundation (Institute for Urban Strategies The Mori Memorial Foundation), located in Tokyo, Japan. The GPCI includes 70 indicators in 6 dimensions: Economy, Accessibility, Environment, Convenience for Living, Cultural Interaction, R&D. The index is calculated for 48 cities annually from 2008 to 2021 (Global Power City Index...).

In the Global Power City Index (GPCI) - in the Economy category, such indicators of human capital are taken into account, such as: the number of people employed and the number of people employed in business support services. In the R&D category, such indicators as: number of researchers, number of TOP world universities, R&D expenditures, number of foreign students, academic success, number of patents, winners of competitions in science and technology, number of patents.

The Smart-city Index is proposed by the International Institute for Management Development (IMD), an independent academic institution with Swiss roots and global reach, founded 75 years ago by business leaders for business leaders and located in Singapore. In 2017, IMD and Singapore University of Technology and Design (SUTD) (Smart City Observatory...) decided to join forces to create a smart city index that would balance measurable economic, technological and humanitarian (quality of life, environment, inclusive) aspects of city functioning.

The original goal was to develop an internationally recognized global smart city index. The first edition was published in 2019, and in total there are already three editions at the moment. The methodology of the Smart-city Index (SCI) provides for the selection of two main

pillars: Structure and Technology. Each is assessed in five key areas: health and safety, mobility, activity, capability and governance. The following indicators of opportunities are included in the "Structure" category: access of most children to quality education; lifelong learning opportunities provided by local institutions. In the "Technology" category: online access to job search; acquiring IT skills at school; online services for starting a business; current internet speed.

It should also be noted that the SCI is closely related to the Human Development Index, which is the main approach to measuring the sustainable development of countries around the world. All cities rated by the SCI are divided into four quartiles (similar to the results of the Human Development Index) and within this group, each city is assigned a rating scale based on its score relative to other cities. In total, more than 100 cities are evaluated (in 2019 – 102 cities, in 2020 – 109, in 2021 – 118).

Table 1 presents the main smart city evaluation indices and information on those components that relate to intellectual factors:

Table 1. Main indexes Smart-city, 2020

Nº	Indexes	The number of indicators	The number of indicators characterizing intellectual factors	The number of Smart-cities
1	City in Motion Index	101	Human capital – 10; Technologies – 17 (26.7%)	174
2	Smart City Index	39	Mobility – 7; Opportunity – 9 (41%)	109
3	Global Cities Index	29	Human capital (30%)	156
4	Global Cities Outlook	13	Innovations (25%)	156
5	Global Power City Index (GPCI)	70	R&D – 8 (11%)	48

The data presented in Table 1 make it possible to clearly see that the weight share of intellectual factors (which are related either to the quality of human capital or to technologies) ranges from 11 to 41 percent. These are actually intellectual indicators. Whereas, as noted above, intellectual factors are quite diverse and already embodied in other resources.

An important point is to determine the impact of individual factors on the final result - the city rating. For this purpose, a correlation analysis was conducted between the CIMI index rank values for 2020 and individual factors. In order to determine the degree of influence of various factors on the effective final CIMI indicator, a correlation matrix was calculated (Table 2):

Table 2 Correlation matrix of resultative and factor indicators of the Index CIMI 2020

	CIMI	X1_Human capital	X2_Technologies	X3_Governance	X4_Urban planning	X5_Economy	X6_Social Cohesion	X7_Environment
CIMI	1							
X1_Human capital	0,744	1						
X2_Technologies	0,704	0,512	1					
X3_Governance	0,712	0,540	0,510	1				
X4_Urban planning	0,577	0,515	0,340	0,376	1			
X5_Economy	0,714	0,477	0,709	0,435	0,414	1		
X6_Social Cohesion	0,339	0,003	0,252	0,284	-0,008	0,134	1	
X7_Environment	0,326	0,023	-0,015	0,239	-0,006	-0,111	0,340	1

Source: developed by authors

According to the results of Table 2, it can be seen that the effective CIMI indicator has a high correlation coefficient, that is, the strongest linear relationship with such factors as: Human capital (Human capital, 0.744), Economy (0.714), Governance (0.712) and Technologies (Technologies, 0.704). All correlation coefficients are statistically significant according to the Student's test. In addition, a close linear relationship was found between such factors as Economy and Technologies (0.709). The economic meaning of such a value of the correlation coefficient is logical, because the economic component of a smart city cannot improve without the development of modern technologies and vice versa. This is confirmed by the scatterplots below:

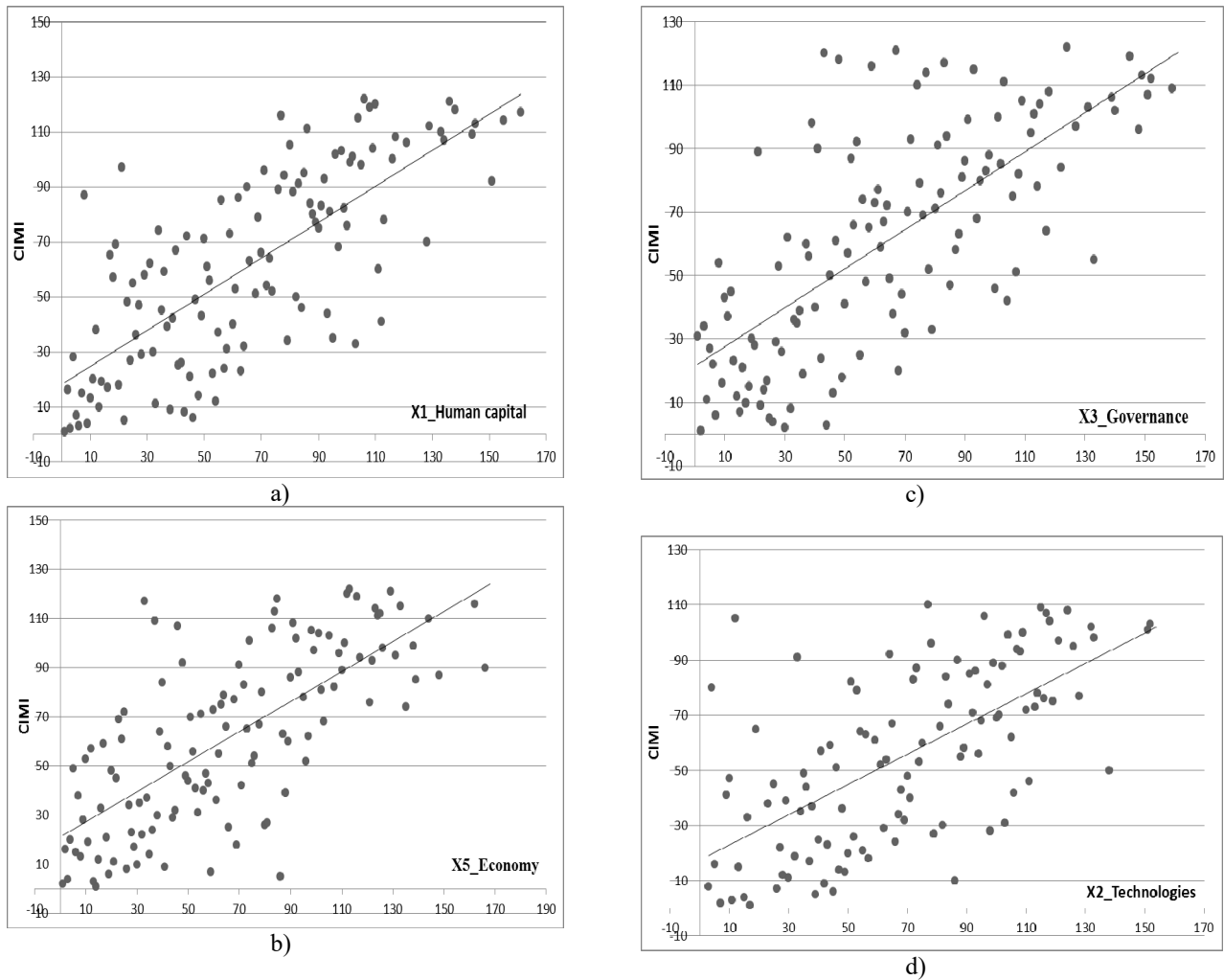


Fig. 1. Dot scatter diagrams between the resultative indicators Index CIMI for 2020 and the most related factors: *Human capital* (a), *Economics* (b), *Governance* (c) ra *Technologies* (d).

Source: developed by authors

Determining rankings and leading cities is the goal of all indexes. Given that each of them has its own characteristics and focuses on different aspects of the functioning of cities, it is also interesting to analyze the ratings of cities according to various indices. In this context, it is advisable to determine the TOP 20 smart cities according to various ratings and analyze the results obtained. Of the entire set of modern indices, the five main indices (above) are the most common and have a certain time series. Also, for the analysis, we will take one year - 2020, for which there are data on all indexes. Table 3 presents the obtained results:

Table 3. TOP-20 Smart Cities by indexes, 2020

№	City in Motion Index	Smart City Index	Global Cities Index	Global Cities Outlook	Global Power City Index (GPCI)
1	London	Singapore	New-York	London	London
2	New-York	Helsinki	London	Торонто	New-York
3	Paris	Zurich	Paris	Singapore	Tokyo
4	Tokyo	Auckland	Tokyo	Tokyo	Paris
5	Reykjavik	Oslo	Beijing	Paris	Singapore
6	Copenhagen	Copenhagen	Hong Kong	Munich	Amsterdam
7	Berlin	Geneva	Los-Angeles	Abu-Dhabi	Berlin
8	Amsterdam	Taipei	Chicago	Stockholm	Seoul
9	Singapore	Amsterdam	Singapore	Amsterdam	Hong Kong
10	Hong Kong	New-York	Washington	Dublin	Shanghai
11	Zurich	Munich	Sydney	San-Francisco	Sydney
12	Oslo	Washington	Shanghai	Sydney	Los-Angeles
13	Chicago	Dusseldorf	San-Francisco	Montreal	Мадрид

14	Stockholm	Brisbane	Brussel	Berlin	Melbourne
15	Washington	London	Berlin	Boston	Beijing
16	Los-Angeles	Stockholm	Madrid	Geneva	Vienna
17	Sydney	Manchester	Seoul	Luxemburg	Dubai
18	Vienna	Sydney	Melbourne	Dubai	Toronto
19	Seoul	Vancouver	Toronto	Melbourne	Copenhagen
20	San-Francisco	Melbourne	moskow	Copenhagen	Zurich

We can observe that the list of leaders is very similar in all ratings. Among those cities that are in the TOP-20 in all five indexes are: London, Sydney and Singapore. Moreover, London takes the first place in three ratings. There are four indices: New York, Paris, Tokyo, Copenhagen, Berlin, Amsterdam, Melbourne. In three: Hong Kong, Los Angeles, San Francisco, Toronto, Zurich, Stockholm, Washington, Seoul. In two: Oslo, Chicago, Vienna, Geneva, Munich, Beijing, Shanghai, Madrid, Dubai. Of course, if you look at the entire sheet of the index, then most likely smart cities will have a place in almost all of them. But in this case, we are talking about the leaders - the twenty best cities.

London: consistently ranked first in all rankings - 2019, 2020 and 2021. It also takes the first place in the following main subdivisions, dimensions of the CIMI rating: human capital, international recognition. The top spot in the Human Capital section is due to London having the most top-tier business schools, as well as the most universities in the world's top 500. It also has a large number of secondary schools, both public and private; a large proportion of the population with secondary and higher education, as well as a wide cultural offer of theaters, museums and art galleries.

Second place according to dimensions: urban planning and management. In the TOP-10 - by mobility, transport and technologies. London is home to more startups and programmers than any other city in the world. The city has launched Smarter London Together, which aims to be a flexible digital master plan to make the city the smartest in the world. This roadmap sets out how to work together with the capital's municipalities and services, from transport to health services. Likewise, the project seeks to work more effectively with the tech community, as well as with universities and other cities. He envisions the future of London as a "global testbed" for innovation, where the best ideas are developed under the highest standards of privacy and security and from there spread around the world. The city has five missions: design, data sharing, connectivity, skills and collaboration (IESE Cities in Motion Index 2020...).

Sydney has developed a smart city strategic framework for smart transformation. The city provides a platform to improve its public spaces and environment, foster its innovation ecosystem, celebrate its rich cultural diversity and strengthen its sense of community. The city is

committed to harnessing the power of technology and data for collaborative innovation to create a prosperous and inclusive future for all its residents. It ranks 17th in the overall rating, 7th in terms of international forecast and first in the region (IESE Cities in Motion Index 2020...).

A smart city strategy has been developed in Sydney, which defines 5 results that are planned to be achieved through the smart, ethical and safe use of data and technologies based on smart infrastructure (Smart city strategic framework...):

1 - Fostering interconnected and powerful communities that enable co-design and effective community decision-making based on open data and skills to innovate and thrive.

2 - Strengthening global competitiveness and attracting and retaining global talent. The aim is to foster the development of an innovation ecosystem and support Sydney as a global magnet for talent.

3 - Securing the future of our environment and increasing sustainability. City conditions are purposefully monitored, forecasted and managed, and new technologies are used to accelerate progress towards a carbon-free future.

4 - Decoration of bright, habitable places. Data and technology are used to optimize the distribution of street space, planning, construction and maintenance of infrastructure.

5 - Provision of effective customer-oriented services.

The city-state of Singapore consistently demonstrates its power as the technological capital of Asia. This is a real smart city, full of technological achievements. Singapore was the first city in the world to launch a system of driverless taxis and buses. The crime rate in the city is one of the lowest in the world, the city has implemented a police robot and remote surveillance systems to ensure the safety of its citizens. It ranks 9th in the overall rating, second in technology and third in the international forecast of the SIMI index (IESE Cities in Motion Index 2020...).

According to the Smart City Index, Singapore ranks first. In 2014, the "Smart Nation" initiative was launched. Creating a city based on digital innovations and technologies, which will meet the ever-changing needs of citizens, involves five main areas: mobility as a shared experience of the community; telemedicine; Smart Nation in the mobile application; business support; learning to be smart (Singapore...).

Land in Singapore is a very limited resource, so a lot of effort is focused on optimizing transport infrastructure: autonomous car fleet for the elderly and disabled, unmanned shuttles, balancing traffic flows over time. In order to achieve the goal of "Healthier citizens" in Singapore, the entire health care system is digitized: consultations are carried out over the Internet, monitoring of patients' condition, assistance to lonely patients with "Chatbots" based on artificial intelligence. All citizens are

encouraged to participate more actively in their shared lives through the Smart Nation network of mobile applications: report municipal issues, use self-driving vehicles, receive environmental alerts on air quality, temperature and precipitation, monitor smart meters, and receive information intended for young people families and elderly residents.

Supporting business in a context of enhanced innovation: The Singapore Digital District Punggol combines the Singapore Institute of Technology with a business park and aims to promote the development of cyber security and IoT technologies by enabling better integration between industry and academia. The fifth goal - Learning to be smart - is realized through education using artificial intelligence within the framework of the TechSkills Accelerator program. The two initiatives – AI for All and AI for Industry – led by AI Singapore – will support the upskilling of 12,000 AI professionals and students. These initiatives encourage citizens to participate in the changes to make the city "digitally ready" and actively lead this movement. The city also has a digital national identity system, a Smart National Sensor Platform and Virtual Singapore – a 3D digital model of the city that can run simulations and support future planning – to name just a few high-tech innovations (Singapore...).

5. Conclusions

The creation of smart cities is an actual trend of modern global sustainable development. The number of initiatives and cities that strive to join the latest processes and provide their citizens with comfortable living conditions is increasing. The practice of each city is unique and interesting. At the same time, achieving leadership positions is always the result of a combination and synergy of certain factors. Among these factors, first of all, it is the quality of human capital, which is realized at different levels. The intensity and success of the use of information and communication technologies in locality management processes, city planning and improvement of the city's living conditions depend on it..

References

- [1] Angelidou, M. (2017): The Role of Smart City Characteristics in the Plans of Fifteen Cities, *Journal of Urban Technology*, DOI: 10.1080/10630732.2017.1348880
- [2] Angelidou, M. (2016) Four European Smart City Strategies *International Journal of Social Science Studies* Vol. 4, No. 4; April 2016 Available online: March 3,2016. 4URL: <http://dx.doi.org/10.11114/ijsss.v4i4.1364>;
- [3] Caragliu, A., Del Bo, C. and Nijkamp, P. (2011), "Smart cities in Europe", *Journal of Urban Technology*, Vol. 18 No. 2, pp. 65-82.
- [4] Caragliua A. (2012), Smartness and European urban performance: assessing the local impacts of smart urban attributes, *Innovation - The European Journal of Social Science Research*, ISSN 1351-1610 (print) / 1469-8412 (online), Volume 25, Issue 2, June 2012, 97-113.
- [5] Collection methodology for Key Performance Indicators for Smart Sustainable Cities // <https://unece.org/DAM/hlm/documents/Publications/U4SSC-CollectionMethodologyforKPIfoSSC-2017.pdf>
- [6] Copenhagen named Monocle magazine's best city in its 2021 Quality of Life Survey // <https://www.pnnewswire.com/in/news-releases/copenhagen-named-monocle-magazine-s-best-city-in-its-2021-quality-of-life-survey-886938304.html>
- [7] Eremia, M., Toma, L., Sanduleac, M. (2016) The Smart City Concept in the 21st Century. 10th International Interdisciplinarity in Engineering, INTER-ENG 2016. URL: <https://www.sciencedirect.com/science/article/pii/S1877705817309402>
- [8] Galperina, L.P., Girenko, A.T., Mazurenko, V.P. (2016) The concept of smart economy as the basis for sustainable development of Ukraine. *International Journal of Economics and Financial Issues*, 2016, 6(88), 307-314 // Available from: <https://www.econjournals.com/index.php/ijefi/article/view/3757>
- [9] Giffinger, R., Fertner, C., Kramar, H., Meijers, E. And Pichler-Milanović, N. (2007) Smart Cities: Ranking of European medium-sized cities. Vienna, 2007. http://www.smartcities.eu/download/smart_cities_final_report.pdf found on 18th of June, 2008;
- [10] Global Cities Report 2021 // <https://www.kearney.com/global-cities/2021>
- [11] Global Liveability Index 2021 Report. Economist Intelligence Unit <https://www.eiu.com/n/campaigns/global-liveability-index-2021/>
- [12] Global Power City Index // <https://mori-m-foundation.or.jp>
- [13] IESE Cities in Motion Index 2020 // iesesight.com/
- [14] Kumar, M.V., Bharat, D. (2012) Smart Economy in Smart Cities. Smart Cities, Local Community and Socio-economic Development: The Case of Bologna. 2017., p.12.
- [15] Lombardi, P., Giordano, S., Farouh, H., & Yousef, W. (2012) Modelling the smart city performance Innovation The European Journal of Social Science Research 25(2), June 2012; DOI: 10.1080/13511610.2012.660325
- [16] Novotny, R., Kuchta, R., Kadlec, J. (2014) Smart City Concept, Applications and Services. *Journal of Telecommunications System & Management* 2014, Volume 3, Issue 2. Doi:10.4172/2167-0919.1000117
- [17] Pozdniakova A. (2017) Digitalization process in Ukraine as a prerequisite for the smart city concept development *Baltic Journal of Economic Studies*. Vol. 3, No. 4, 2017. P.206-215.
- [18] Pozdniakova, A. (2019) Analysis of smart city architecture models. *Vcheni zapiski TNU imeni V.I.Vernadskogo. Seria: Ekonomika I Upravlinnja*. Tom 30 (69). N4, 2019, pp.105-110.
- [19] Quality of Living survey 2019 // <https://www.mercer.com>
- [20] Singapore: The World's smartest city // thalesgroup.com/
- [21] Smart City Observatory // <https://www.imd.org/smart-city-observatory/home/>
- [22] Smart Cities: Issues and Challenges Mapping Political, Social and Economic Risks and Threats Edited by Anna Visvizi Miltiadis D. Lytras. Elsevier, 2019, 374 p.
- [23] Smart city strategic framework. City of Sydney. C:/Users/User/Downloads/Smart%20City%20Strategic%20Framework.pdf
- [24] Sureshchandra, S.M., Bhavsar, J.J.& Pitroda, J.R. (2016) Review on identification of success factors for designing of Smart Cities. *IJSTE – International Journal of Science Technology & Engineering*. Volume 2. Issue 09. March 2016, p. 125 – 133.ISSN (online): 2349-784X.
- [25] World Bank Open Data // <https://data.worldbank.org>
- [26] World City Populations 2022 // <https://worldpopulationreview.com/world-cities>