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Original Scientific Article

THE SMART CITY CONCEPT AS A PARTIAL FORM OF ACHIEVED SUSTAINABLE DEVELOPMENT

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Apstrakt: The idea of establishing a city based on different, greener, and more sustainable foundations is not new and first emerged at the end of the 1980s. Smart cities aim to facilitate increasingly complex urban living for their inhabitants, as the urban population exhibits a constant upward trend. The primary goal of these new urban entities is to enable residents to live more easily, functionally, healthily, and better, with the most rational use of time, so that more “free time” remains. In other words, each resident should save time in performing daily activities, thereby allowing this freed-up time to be utilized more wisely and healthily. This possibility is made feasible through the widespread use of advanced technologies, without whose integration the concept of a smart city cannot be realized. The intention is to incorporate technology into all or as many city services as possible, with the aim of enhancing the quality of life for residents in cities whose populations are increasing uncontrollably. The concept of smart cities is based on the implementation of IoT (Internet of Things) and ICT (Information and Communication Technologies) devices. This includes various sensors, LED lighting, data collection and analysis devices, utility services, and all services that can be simplified and accelerated through mass technological utilization. The paper presents a method for measuring the implementation of the smart city concept by using an index of smart cities developed by IMD, the World Competitiveness Center. Although this index is not the only one used for such measurements, it is among the most frequently applied and has been in use since 2019.

Key words: *smart city, Artificial Intelligence (AI), sustainable development, Internet of Things (IoT), Information and Communication Technologies (ICTs), urban infrastructure.*

1. INTRODUCTION

Modern information technologies, digitalization, and the increasingly prevalent use of artificial intelligence (AI) are pushing the boundaries in every aspect of life and business. The capabilities for implementing radical or incremental innovations are expanding across all domains, especially in the fields of sustainable development and the green economy, which in turn influence the formation of new urban entities - smart cities.

The concept of sustainable development was first introduced at the United Nations Conference in Rio de Janeiro in 1992, where a systematic enumeration of demands that would clearly define the agenda of this concept was also presented (Vujić, 2022). However, the UN General Assembly only a decade ago officially defined 17 interconnected goals on a global level. The Millennium Development Goals (MDGs) served as a foundation for creating a more sustainable future (UN, 2015).

Until 2030, the realization of these goals is concentrated in smart cities, which, through digital technologies, participate in creating a sustainable ecosystem that also considers social issues (Alberti, Senese, 2020; Munitlak Ivanović, 2018). For example, when evaluating the success of a geographic concept – such as a smart city – its competitiveness and the success of economic activities cannot be solely assessed through profit levels, productivity, or employment rates. The success of a smart city can only be evaluated by considering a complex matrix of political, social, and cultural dimensions.

It can be said that, within a smart city, water resources, energy, management, and various forms of local cooperation are managed thoughtfully (Munitlak, 2020). Concepts such as sustainability, waste management, civic movements, and innovation represent shared goals that are addressed differently in each city, depending on the challenges it faces (Munitlak Ivanović, Špoljarić, 2025).

A smart city assumes the use of smart technologies for data exchange, including Internet of intelligent devices (internet of things-IOT) and information and communication technologies (ICT) in order to increase energy efficiency, reduce GHG and improve the quality of life of smart city residents (De Guimarães et al. 2020).

2. METHODS

This work predominantly uses the “desk research” method, collecting and analyzing available theoretical works and books of eminent authors, as well as very fresh numerical data from the field published in the annual reports of international organizations. Some numerical data collected from annual reports are combined in Table 1 and enabled a temporal comparative analysis for the selected period 2019-2025. year. The paper also used a schematic representation of the theoretical synthesis (Scheme

1 and Figure 1). The above implies that the authors of the paper used the desk research method, the comparative method of time series data, as well as the methods of analysis and synthesis.

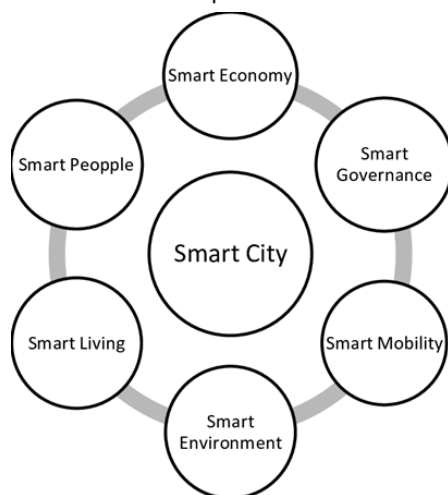
3. DISCUSSION

The concept of a smart city is intended for residents, whose number in cities is constantly growing, to live easier and better, and for digital technologies to be incorporated into city services, which would improve the quality of life of city residents. With the implementation of the concept of sustainable development, smart cities should shorten the time spent on performing daily activities, so that the excess time created in this way can be used better and smarter (Stojkov Pavlović, 2023).

Pereira indicates that a smart city aligns physical, social, business and information communication infrastructure to raise the "intelligence of the city" (Pereira et al., 2018). Mahmood points out that a smart city is an advanced modern city that uses ICT and other technologies to improve the quality of life, competitiveness, operational efficiency of urban services, while ensuring the availability of resources for current and future generations in terms of sustainable social life, taking into account economic and environmental aspects (Mahmood et al., 2018). Zanella indicates the primary goals of the original smart cities in terms of improving the quality of life of the inhabitants of those cities by reducing the contradictions of demand and supply in different functionalities (Zanella et al., 2014). In modern, smart cities, as Ejaz points out, the requirements are particularly directed towards efficient and sustainable solutions in energy management, transport, health care, management and the like, in order to meet the needs for a quality life of the inhabitants of these cities (Ejaz et al., 2017).

The scheme also indicates the different components that can make up a smart city. For some authors, these are: smart community, smart energy, smart transport and smart health care are key components (Giffinger et al., 2007). However, in practice, the components of a smart city vary from city to city depending on the area of interest or the possibilities of the local community, that is, depending on the research period (each subsequent year analyzes more and more indicators). For example, the administration of a smart city can consider the inclusion of a disaster management system in a smart community, while the administration of another city plans to integrate a waste management system, and others introduce smart lighting aimed at energy sustainability and maximum capacity utilization (that is, switching from classic to LED public lighting).

Scheme 1: Six components of a smart city



Source: <https://www.researchgate.net/figure/Six-characteristics-of-smart-city-adopted-from-Giffinger-et-a>

3.1 The impact of digital technologies as a key condition for the development of smart cities

The Internet of Things (IoT) and information communication technologies (ICT) that are used in the implementation of the concept of a smart city are usually sensors, devices that collect and analyze data and LED lighting in public lighting, that is, technology that is needed for data generation, data management and application handling. Based on the data collected by the devices, an analysis is carried out in order to adapt the current situation to the needs of the city, i.e. the needs of the residents, in the domain of infrastructure, communal services, parking services and the like. In this way, the life of citizens becomes easier, more organized, simpler, more flexible, safer and cheaper (Munitlak Ivanović, Špoljarić, 2025).

It could be said that a smart city is an application of the Internet of Things and therefore has the basic operating mechanisms from IoT. In general, the application of IoT (Internet of Things) leads to the basic components for the realization of smart cities, i.e. data generation, data management and application handling. Technological advances in global ubiquitous computing (UC), wireless sensor networks (VSN), and machine-to-machine (M2M) communication have significantly and positively impacted the Internet of Things (Degushi, 2020). The principle on which the Internet of Things works is based on enabling UC to use recognizable smart devices, where the role of human interaction is minimized (Adel, Alani, 2024). Based on all of the above, the conclusion is that the essence of the concept and organization of a smart city lies in extremely developed information and communication technologies and the networks that connect them. It is essentially about society 5.0 (Deguchi, 2020).

The IT society (Society 4.0) has imperceptibly moved to Society 5.0 and Industry 5.0. In Society 4.0, the primary drivers of development were information and communication technologies that contributed to the rapid development of automatic machines, robots and artificial intelligence (AI). The coexistence of Industry 5.0 and Society 5.0 implies the use of artificial intelligence in all dimensions of life (Munitlak Ivanović, Špoljarić, 2025). Comfort, high-quality life and vitality are three important features that characterize Society 5.0. The unity of cyber and physical space, the balance of economic growth and the solution of social problems, freedom from unnecessary activities and the efficient use of such freed excess time (regardless of the age of society members) are the characteristics of a smart city and Society 5.0 (Mishra, Singh, 2023).

The idea of creating smart cities is not exactly new. It is found in the works of Broadus (Broadus, 1987) as early as 1987. It was further elaborated more than two decades ago in the work of authors Hood and Wilson (Hood, Wilson, 2001). These ideas have their starting point in the creation and creation of mutual relations between human capital, social capital and the infrastructure of information and communication technologies (ICT), with the aim of creating more intensive and sustainable economic development and a better quality of life (Ramaprasad et al., 2017).

The concept of a smart city is subject to change, following the development and improvement of technologies, mainly information and communication technologies. People take advantage of the convergence of these technologies to improve the quality of their lives (Vujić et al., 2024). This advancement in the field of high technology has brought about a change in the term of what is known as a 'city' to the term 'smart city'.

3.2. Smart Cities Index (SCI) - a way of measuring the intensity of "smartness" of cities

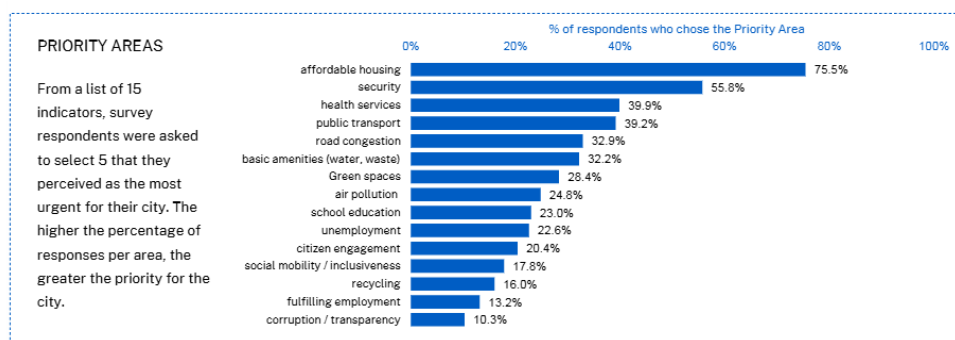
Smart cities can be classified according to different indicators, depending on which characteristics are measured and observed. Depending on the selected and implemented indicator, the obtained result also depends, but it has certainly been observed that the degree of "smartness" of cities affects its competitiveness (Azevedo et al., 2018). This encourages the effort for as many cities as possible to strive for greater sustainability and in this way for more cities to meet the concept of a smart city despite the growing environmental problems that accompany the exponential growth of the city's population. Indexes can measure citizens' experience of the quality of life in the city they live in, thanks to the data that the observed city has, from the data provided by the Human Development Index (HDI). The subject of measurement can be various data, depending on the index used for measurement, for example: life expectancy, expected years of schooling, average years needed to complete education, income per capita of the city and the like.

The most commonly used index of smart cities is the one created by IMD, the World Competitiveness Center, based in Singapore. This index measures the balanced

relationship between economic and technological aspects of smart cities on the one hand, and elements of humanity on the other (quality of life in the city, inclusiveness, environment) (World Competitiveness Yearbook). The creators of the index have published a report on the competitiveness of countries and cities every year since 1989, measuring the performance of 69 economies based on more than 330 criteria that measure different elements of competitiveness. The index, created by the IMD company, includes 15 indicators on the basis of which the ranking is made: 1. affordable housing, 2. traffic congestion and road congestion, 3. corruption vs. business transparency, 4. health services, 5. job satisfaction, 6. air pollution, 7. unemployment, 8. public transport coverage, 9. school education (preschool education, primary and secondary education), 10. safety, 11. sanitary conditions (water and waste), 12. recycling, 13. coverage of green areas, 14. engagement of citizens in the civil sector, 15. social mobility and inclusiveness. It is important to note that the ordinal numbers listed above, from 1 to 15, do not show the degree of importance of the observed indicator. From a list of 15 indicators, respondents choose 5 that they consider to be the most urgent to solve in their city. The total length of each "bar" in Figure 1 indicates the percentage of respondents who included a given area as one of their 5 choices. The higher the percentage that refers to one of the 15 offered areas, the more significant that indicator is for a specific city.

Figure 1 is an example of how the measurement of the 15 indicators looks in its final form. This procedure is repeated for each city separately. Once the results for each city are obtained, a comparison is made and finally the cities are ranked, as shown in Table 1.

Figure 1: An example of the selection of priority indicators shown as the percentage of respondents who chose their 5 priority areas



Source: IMD Smart City Report 2025, p. 14

As mentioned, after collecting data for each city, indices for each city are obtained. The results of the ranking of cities can be presented in tabular form and it is possible to easily compare them in the observed time.

Table 1: Ranking of cities according to the value of the Smart Cities Index (SCI) in the period 2019-2025. year

Grad	Rang u 2025. godini	Rang u 2024. godini	Rang u 2023. godini	Rang u 2021. godini	Rang u 2020. godini	Rang u 2019. godini
<i>Cirih</i>	1	1	1	1	1	1
<i>Oslo</i>	2	2	2	2	2	2
Kanbera	8	3	3	-	-	-
Kopenhagen	7	6	4	5	3	4
Lozana	10	7	5	4	-	-
London	6	8	6	3	10	3
Singapur	9	5	7	7	7	10
Helsinki	11	9	8	9	5	6
Ženeva	3	4	9	6	8	7
Stokholm	18	11	10	11	9	6
Hamburg	20	14	11	8	6	-
Peking	14	13	12	17	22	30
Abu Dabi	5	10	13	12	14	16
Prag	12	15	14	10	4	8
Amsterdam	17	18	15	13	11	11
Seul	13	17	16	18	20	23
Dubai	4	12	17	14	19	23
Sidnej	32	22	18	29	32	22
Hong Kong	19	20	19	33	34	38
Minhen	24	21	20	34	35	40
Tai Pei	23	16	26	-	-	-
Šangaj	15	17	25	-	-	-
Ljubljana	16	32	-	-	-	-

According to: IMD Smart City Report 2025; IMD Smart City Index 2024; IMD Smart City Index 2023.

Note: The ranking of the first 5 cities in 2022 are: 1. Zurich; 2. Oslo; 3. Canberra; 4. Geneva and 5. Singapore. For unknown reasons, the authors of this paper could not find ranking data for the remaining 15 smart cities, although they subscribed to the channel <https://smartcitiesindex.org/smartcitiesindexreport2022>.

4. RESULTS AND DISCUSSION

Table 1 shows that two cities, Zurich and Oslo, are in the first and second places in the observed period from 2019 to 2025. The cities of Canberra, Copenhagen, Lausanne, London, Singapore and Geneva are always in the first 10 cities in the observed period. The cities of Beijing, Abu Dhabi and Hong Kong have the most significant positive jump from 2019 (Beijing 30; Abu Dhabi 16; Hong Kong 38) to 2025 (Beijing 14; Abu Dhabi 5; Hong Kong 19). The cities of Shanghai and Ljubljana, which were not in the top 20 smart cities in 2019, were ranked in the top 20 cities in just 6 years (Shanghai 15 and Ljubljana 16). It is similar in the city of Tai Pei, which was not in the top 20 cities in 2019, only to find itself in a high 23rd place this year. However, this is a worse ranking than last year in 2024, when Tai Pei was ranked 16th, that is, in the top 20 smart cities.

5. CONCLUSION

The concept of a smart city, which appeared in the first papers as early as 1987, points to the conclusion that it appeared as a response to the challenges of sustainable development that appeared through the UN strategy of the Sustainable Development Goals (SDG). Smart city as a concept is conceived primarily as an IoT application domain. For its realization, intensive use of information and communication technologies (ICT) is necessary in the various services that this urban form of housing should provide. Most often, it is about sensors, devices that collect and analyze data, LED lighting in public lighting, that is, the technology required for data generation, data management and application handling. On the basis of the information collected in this way, further analysis is carried out, in order to adapt the situation as much as possible to the residents of the smart city. Most often, it is about improving infrastructure, communal services, parking services and the like, with the aim of making life in the city easier, more organized, simpler, more flexible, safer and cheaper. All of the above has another important goal, to make life easier for all age groups so that they have more free time.

This paper has presented some of the characteristics and different approaches to the concept of a smart city in terms of definitions, standards and implications.

Through the identified indicators that make up the Smart Cities Index (SCI), developed by the institution IMD World Center for Competition, the synthesized results for more than 20 smart cities in the defined period (2019-2025) are presented. In order to measure the success of the implementation of a smart city, it was necessary to develop IoT (Internet of Things) and ICT (information and communication technologies) and make them widely available, but also financially not overly burdensome. The basic imperative is to make urban environments smarter in the sense that they create a

more sustainable, pleasant, greener and generally more beautiful place for their residents to live in for all age groups.

The concept of a smart and sustainable city is still in development. Especially during the pandemic, numerous weaknesses were shown when many of the listed cities were epicenters of the infection, which completely exposed their unwillingness to deal with such and similar calamities. The above sufficiently indicated “how far cities and human settlements are from being safe, resilient and sustainable” (Vujić, 2022).

There are only two cities (Zurich and Oslo) that have consistently reached first and second place when looking at the implemented smart work indicators over a longer period (from 2019-2025). They are followed by Canberra, Copenhagen, Lausanne, London, Singapore and Geneva, which are always in the top 10 cities in the observed period.

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REFERENCES

1. Adel, A., & Alani, N. H. (2024). Human-Centric Collaboration and Industry 5.0 Framework in Smart Cities and Communities: Fostering Sustainable Development Goals 3, 4, 9, and 11 in Society 5.0. *Smart Cities*, 7(4), 1723.
2. Alberti, A., Senese, M. (2020). Developing capacities for inclusive and innovative urban governance. *Governance for urban services: Access, participation, accountability, and transparency*, 127-152.
3. Azevedo Guedes, A. L., Carvalho Alvarenga, J., Dos Santos Sgarbi Goulart, M., Rodriguez y Rodriguez, M. V., Pereira Soares, C. A. (2018). Smart cities: The main drivers for increasing the intelligence of cities. *Sustainability*, 10(9), 3121.
4. Broadus, R.N., (1987). Toward a definition of bibliometrics. *Scientometrics*, 12, 373–379.
5. De Guimarães, J. C. F., Severo, E. A., Júnior, L. A. F., Da Costa, W. P. L. B., Salmoria, F. T. (2020). Governance and quality of life in smart cities: Towards sustainable development goals. *Journal of Cleaner Production*, 253, 119926.
6. Deguchi, A. (2020). From smart city to society 5.0. *Society*, 5, 43-65.
7. Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanovic, N., Meijers, E. J. (2007). *Smart cities*. Ranking of European medium-sized cities. Final Report.
8. Hood, W. W., Wilson, C. S. (2001). The literature of bibliometrics, scientometrics, and informetrics. *Scientometrics*, 52, 291-314.

9. IMD Smart City Report 2025: https://imd.widen.net/s/psdrsvpbk7/imd_smart_city_2025_report
10. IMD Smart City Index 2024: https://www.coit.es/sites/default/files/imd_smartcityindex-2024-full-report.pdf
11. IMD Smart City Index 2023: <https://www.smacite.eu/en/dissemination/posts/93-imd-smart-city-index-2023>
12. Mahmood, Z., Mahmood, Wheeler. (2018). *Smart Cities*. Springer.
13. Mishra, P., & Singh, G. (2023). Sustainable smart city to society 5.0. In *Sustainable Smart Cities: Enabling Technologies, Energy Trends and Potential Applications* (pp. 39-57). Cham: Springer International Publishing.
14. Munitlak Ivanović, O., Špoljarić, T. (2025). *The Importance of Smart Cities as a Modern Urban Settlement Solution*. Chapter 2; Third International Thematic Monograph: Technogenesis, Climate Change and Environmental Protection, Scientific-professional society for environmental protection of Serbia "ECOLOGICA", pp. 42-55.
15. Munitlak Ivanović, O. (2018), Implementacija ciljeva održivog razvoja primenom milenijumskih ciljeva, Monografija, *Institut ekonomskih nauka*, Beograd.
16. Munitlak Ivanović, O., (2020), Razvoj pametnih gradova – primer četvrte industrijske revolucije, *Ecologica*, 27(97), pp.15-21.
17. Pereira, G. V., Parycek, P., Falco, E., Kleinhans, R. (2018). Smart governance in the context of smart cities: A literature review. *Information Polity*, 23(2), 143-162.
18. Stojkov Pavlović, A., (2023) Perspektive razvoja pametnih gradova u Srbiji, *Ecologica*, 30 (110), 269-277.
19. UN, 2015. <https://sdgs.un.org/goals>
20. Vujić, M., Nadić, D., Munitlak Ivanović, O. (2024). Ecological modernization – Efficiency and Challenges of the Current Concept. International Scientific Conference: Green Economy and Adaptation of Industry to climate Changes, 22-24 April 2024, Belgrade, Serbia; Scientific and Professional Society for Environmental Protection of Serbia „Ecologica“, Book of Abstracts, p. 81
21. Vujić, M., (2022). Tri decenije održivog razvoja – Nastanak, dominacija, slabosti i perspektiva, *Sociološki pregled*, 56(4), pp. 1270-1297.
22. World Competitiveness Yearbook, <https://www.imd.org/centers/wcc/world-competitiveness-center/>
23. Zarella, A., Bui, N., Castellani, A., Vangelista, L., Zorzi, M. (2014). Internet of things for smart cities. *IEEE Internet of Things Journal*, 1(1), 22-32.