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Smart City and the Quality of Public Administration Services in the Slovak Republic

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Abstract: *The concept of smart cities is an opportunity to solve real problems of public administration. In Slovakia, there is a growing interest in the implementation of modern technological solutions within local governments related to public services. Some municipalities show interest in supporting critical areas such as education, mobility, environment, healthcare, security, sustainable development, as well as the engagement of citizens. The paper´s aim is to analyse and identify the current state of development of smart cities in Slovakia, especially the city of Bratislava and to propose improvements in the quality of service provision for residents and visitors. The specific focus will be put on the analysis and evaluation of the mid-term strategy until 2030 according to the IMD index of smart cities, digitalization of public services, indicators of the digital competitiveness of Slovakia and Bratislava and the budget expenditures for 2024 priority areas.*

1. INTRODUCTION

The smart city concept implementation affects the economic, social and environmental aspects of life. The elements of the concept are interconnected and create a system based on the principles of sustainable development. Public administration, private sector and civil society entities enter this system and ensure that the set goals would be achieved. Smart cities are more efficient, have more opportunities to create jobs, ensure economic growth and improve the social inclusion and well-being of their residents.

The European Commission in the "European Innovation Partnership - Smart Cities and Communities" defines smart cities as systems where people interact with each other and use energy inputs, materials, services and finances to accelerate the process of sustainable economic development, raising the standard of living. The mutual interactions become "smart" through the strategic use of information and communication infrastructure and services in the process of transparent urban planning, development and management, which respond to the social and economic needs of the population. Modern information and communication technologies have become a means of effective urban management. They enable the collection and assessment of big data that relate to the quality of urban services and support interactivity between self-government and residents. Computerization can bring an upgrade in management efficiency and optimize processes in key areas such as transport, energy, water supply, waste management and healthcare.

2. SMART CITY CONCEPT IN SLOVAKIA

The concept of smart cities represents an opportunity to solve real problems of public administration. A smart city is a modernized urban area where everything, from transportation to energy,

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can be connected to digital technologies that enable the two-way transfer of information between the city administration, the residents and visitors. By technologies such as "Internet of Things", "Big Data", "Machine Learning" and their interconnections, city officials can apply direct interaction with residents and relevant infrastructure and ensure monitoring of the state of smart city concept development and citizens' requests regarding services in favour of a higher quality of life for residents.

The concept of smart cities is most widely applied in six areas that can connect. They include smart public administration, smart services and life, smart environment and society, smart mobility, and smart economics. In the Slovak Republic, the state acts as a coordinator in the fulfilment of economic policy goals, and local governments possess a considerable degree of freedom in the key areas of smart city development and exercise their competences in taking care of the residents' needs and the development of the territory.

The action plan for smart cities and regions for 2023–2026 (Ministry of Investments, Regional Development and Informatization of the Slovak Republic, 2022) is a strategy to support smart regions and cities in the coordination and use of EU funds, especially the European Social Fund in 2021-2027, with the aim of increasing the ability of state administration to provide comprehensive support to self-governments. The action plan is in line with the long-term sustainable development strategy of the Slovak Republic "Vision and Strategy for the Development of Slovakia until 2030", which aims to improve the predictability of public policies, the efficiency of the use of public resources and the stability of the business environment.

The measures for the development of smart municipalities in Slovakia concern the following areas:
- development of personal and professional capacities,
- education for smart management and innovations in public administration,
- support for the flow of exchange data between municipalities and the state administration,
- development, support and use of geographic information systems (GIS),
- innovative public procurement and innovations in public administration,
- development and support of ICT and information systems sharing,
- international cooperation and exchange of knowledge in smart solutions development,
- evaluation and testing of innovative smart solutions,
- support of test environments for testing/experimentation and scaling of innovative solutions in the field of smart cities and regions
- support of small and medium-sized entrepreneurs and innovative businesses for the development of smart solutions (Ministry of Investments, Regional Development and Informatization of the Slovak Republic, 2022).

For the development of smart cities and regions in Slovakia, funds from the Effective Public Administration Operational Program of almost 13 billion EUR will be used. The budget will be administered via the Recovery and Resilience Plan of the Slovak Republic. This program for the period 2021-2027 was intended for the following areas:
1. A more competitive and smarter Slovakia - allocation of 1.9 billion EUR with the aim of supporting digitization, development of skills and digital connectivity, support of research, innovation, and science, and strengthening of small and medium-sized enterprises.
2. A more connected Slovakia – allocation of 2 billion EUR for constructing and repairing roads, reconstruction of local roads, with the aim of ensuring a safe and sustainable national transport network, local and regional mobility.

3. Fund for fair transformation - allocation of 441 million EUR for the Nitra region, the Banská Bystrica region and the Košice region to solve economic, social and environmental impacts of climate changes with the aim of transitioning to carbon neutrality.
4. A more social and inclusive Slovakia - allocation of 3.3 billion EUR will support inclusive and high-quality education, social services for disadvantaged citizens, family counselling centres, Roma communities, material and food aid for persons dependent on this assistance, as well as the acquisition of skills for inclusion and better adaptability of labour force based on the requirements of the labour market.
5. Europe closer to citizens - allocation of 400 million EUR for the support of culture and natural heritage, public sports fields, sustainable tourism and safety in the regions, intended to support economic, social and environmental development at the local and regional levels.
6. Greener Slovakia - allocation of 4.2 billion EUR for nature protection, biodiversity, protected rural areas, exploration, remediation, monitoring of environmental brownfields, investments in environment-friendly public transport, construction of bicycle paths, reduction of greenhouse gas emissions, adaptation to climate change, etc.

Cohesion policy is a strategy aimed at keeping up competitiveness at the global level and reducing differences in the development of EU member states and their regions. It particularly focuses on rural regions, disadvantaged by various demographic and natural conditions, or affected by various changes in the industry. The EU funds support the above goals through structural and investment funds (ESIF).

The Slovakia Recovery and Resilience Plan became a special financial tool for solving economic and social issues. This plan represents a comprehensive package of reforms and investments, the main goal of which is to achieve the EU average standard of living in Slovakia. It was developed and approved based on Regulation (EU) 2021/241 of the Parliament and of the Council of February 2021, which established a Mechanism to support recovery and resilience. The main priorities of the Plan are quality education, better healthcare, efficient public administration and digitization, green economy, science, research and innovation.

Table 1. Priorities and Components of the Recovery Plan of the Slovak Republic

Green economy	Component 1: Renewable energy sources and energy infrastructure Component 2: Restoration of buildings Component 3: Sustainable transport Component 4: Decarbonisation of industry Component 5: Adaptation to Climate Change
Education	Component 6: Availability, development and quality of inclusive education at all levels Component 7: Education for the 21st century Component 8: Increasing the performance of Slovak universities
Science, research, innovation	Component 9: More effective management and strengthening of funding for research, development and innovation Component 10: Attracting and retaining talent
Health	Component 11: Modern and affordable health care Component 12: Humane, modern and accessible mental health care Component 13: Affordable and long-term quality social and healthcare
Effective public administration and digitization	Component 14: Business Environment Improvement Component 15: Justice reform Component 16: Fight against corruption and money laundering, security and protection of the population Component 17: Digital Slovakia (State in mobile, cyber security, fast internet for everyone, digital economy)

Source: Recovery and Resilience Plan of the Slovak Republic (2021)

Originally, 6 billion EUR (in grants) was allocated for the Plan, but during the years 2022 to 2023, the REPowerEU chapter was added, thanks to which Slovakia received an additional amount of 403 million EUR for new green measures. Each priority of the Recovery and Resilience Plan of the Slovak Republic is part of one of the 17 program components (Table 1).

The integrated package of reforms and investments intended for Slovakia via the Recovery and Resilience Plan is based on priorities focused on the current problems of Slovak economics and the most important societal challenges. From the total amount of 6.4 billion EUR, the amount of 2.09 billion EUR was utilized by the end of the 1st quarter of 2024 to improve the efficiency of universities, more modern and better health care, renewable energy sources and energy infrastructure, sustainable transport and others.

3. SMART CITY CONCEPT FOR BRATISLAVA

Bratislava is the capital of the Slovak Republic, with the highest standard of living and the highest number of inhabitants. As of December 31, 2021, the registered population was 476,922 residents. The Petržalka district has the largest population, followed by the Ružinov and Staré Mesto districts. The forecast for the rise of population in Bratislava indicates an insignificant change in growth and only a slight increase of population by 3.22% in the following 10 years.

Table 2. Population of 17 Bratislava urban districts in 2021 and forecast until 2035

No.	Name of the urban district	Area in km²	Number of residents	Population density per 1 km²	Population forecast until 2035 (in thousands)
1.	Čunovo	18,6	1 751	94	2
2.	Devín	14	2 024	144	2,5
3.	Devínska Nová Ves	24,2	17 112	707	16,3
4.	Dúbravka	8,6	35 759	4135	36,3
5.	Jarovce	21,3	2 923	137	3,9
6.	Karlova Ves	11	35 078	3203	33,7
7.	Lamač	6,5	7 786	1190	8
8.	Nové Mesto	37,5	44 876	1197	49
9.	Petržalka	28,7	113 215	3948	107,5
10.	Podunajské Biskupice	42,5	23 465	552	24
11.	Rača	23,7	26 049	1101	32
12.	Rusovce	25,6	4 459	174	5
13.	Ružinov	39,7	81 741	2059	86
14.	Staré Mesto	9,6	46 929	4893	50
15.	Vajnory	13,5	6 043	447	6,4
16.	Vrakuňa	10,3	20 407	1982	19,3
17.	Záhorská Bystrica	32,3	7 305	226	10,4
	SPOLU		**476 922**		**492 300**

Source: Metropolitný inštitút Bratislavy (2023)

Due to the forecasts, it can be said that Bratislava has growth potential, albeit slow in the coming years. Bratislava is an attractive city, and it is assumed that growth will increase with ongoing global processes. Migration increases the population and partially mitigates aging, which affects the planning of most activities. Without migration, the aging of the numerous senior generations would be much faster, and the reduction of the population would be irreversible due to the low level of fertility. Migrants change the educational, social and cultural composition of the population. It is assumed that the number of women of reproductive age will gradually decrease, and the low number of newborns will have an impact on the number of children in preschool and school age and the number of school buildings.

In Bratislava, there are different estimates of people who immigrated from different Slovak regions, and their records are insufficient, which distorts their real number. The development and functioning of the city depend on the number of the population and its aging. However, aging in the capital will not be as intensive as in other regions of Slovakia, but even here it is assumed that the number of senior citizens will be above average. These factors affect the areas of city life and are a challenge for the self-government responsible for urban development and operation.

Interregional disparities in Slovakia are large, which is why Bratislava is attractive to migrants from other Slovak regions. The city is experiencing a great construction boom, high economic performance and labour productivity. Each of the 17 urban districts of Bratislava has a special character, represents its specificities and requires a different approach to development. Outskirt districts such as Vajnory, Rača, Čunovo, Rusovce and Devínska Nová Ves have a rural character. They suffer from a lack of pre-schools, primary schools, health facilities, access roads are not repaired, they are disproportionately loaded, long lines of cars create traffic jams, and the traffic often collapses. Bad transport infrastructure affects other parts of the city, and therefore the city should invest primarily in this infrastructure.

Bratislava has developed a smart city concept since 2018 under the name Bratislava smart city 2030 (2018). The goal of the smart city concept is to achieve a higher quality of life in Bratislava. The concept was developed following strategic documents at the international, national and local levels. Referring to urban development, the cooperation of the self-government administration with the public and residents, state administration bodies, entrepreneurs, research and educational institutions is important. Within its smart city strategy, Bratislava focuses on 12 smart areas:

1. City administration refers to effective communication with residents about the administration and functioning of the city, including the use of mobile applications, the openness of offices to the public, the involvement of residents in decision-making, the effectiveness of internal self-government processes, implementation of innovative technologies in practice based on cooperation between the city and residents.
2. Transport policy requires the active participation of the self-government with institutions to collect data on transport and their subsequent use for smart management of transport, communication with residents about their views on modern urban public transport policy, support and use of shared bicycles and scooters.
3. Energy policy focuses on energy saving and lower costs, reduction of the negative impact on the quality of the environment, and the use of renewable energy sources.
4. The environment policy focuses on green areas in the city, planting new trees and green, protecting water and soil. A good example is the Community Garden project, which can be replicated, and residents can establish a community garden close to their residences.
5. Circular economy policy refers to smart waste management in waste recovery, reduction of municipal waste landfills, and installation of waste sorting containers. An example of a successful project is the semi-underground containers from the waste management company OLO, a.s., which, in cooperation with the company Sensoneo, have built-in RFID chips for electronic waste registration to detect the filling of containers and improve waste collection.
6. Entrepreneurship policy refers to better communication of the city administration with start-up entrepreneurs, support of opportunities for innovators, support of research and the private sector.
7. Public space policy refers to the domain of several accessible and revitalized public spaces for city residents.

8. Social cohesion policy refers to the improvement of the social services quality in facilities such as dormitories, day centers and facilities for senior residents, their upgrading and the support in favour of various educational programs and leisure activities.
9. Education policy represents the involvement of youth in various innovative projects and training courses, workshops, awareness-raising campaigns about the importance of sorting and recycling waste, and activities in favour of senior residents.
10. Culture policy refers to the modernization and reconstruction of cultural monuments, beautification of cultural heritage, higher comfort for visitors to monuments.
11. Tourism policy includes the supports of tourism development and attracting visitors to Bratislava via the Bratislava Card, which allows tourists to get to know Bratislava at a discounted price and offers free entry to selected galleries and museums and unlimited travel by public transport.
12. Sports policy is supported by the planned Health and Sports Campus project for the Petržalka district, including the construction of a multifunctional hockey hall, locker rooms, education and training areas and an athletics stadium.

For the years 2024-2026, a financial plan for priority areas funding was drawn up. The city self-government body wants to continue the ongoing projects in public infrastructure, revitalization of public spaces, transport, environment, and green care. Part of the priorities will be financed from city income, personal income tax, parking policy income, other taxes and various local fees, business income, rent, gambling proceeds, etc.

The city plans to increase property taxes by 35% and waste collection fees by 30% from 2024. Bratislava will also draw on EU funds, especially from the Cohesion Fund, and the state budget. Capital expenditures will be financed from the Cohesion Fund, mainly the modernization of trolleybus routes, renewal of the public transport fleet, completion of the tram line in Petržalka, and public and transport infrastructure projects.

The source of the capital income is also funds from the sale of city buildings, land, etc. The draft budget of the city of Bratislava for the years 2024-2026 is divided into current expenses (79% of the budget) and capital expenses (21% of the budget).

Table 3. Distribution of capital expenditures of the Bratislava budget for 2024 (in %)

Education and leisure	0,2
Administration and management of city property	12,1
Mobility and public transport	7,3
Effective and transparent self-government	4,4
Culture, sport, tourism services support	3,4
Social aid and social services	1,0
Order and safety	0,3
Public infrastructure	70,9

Source: Based on Hlavné mesto SR Bratislava (2023)

In capital expenditures, the highest amount (70.9%) is allocated to public infrastructure, 12.1% to the administration and management of city property, and 7.3% to mobility and public transport. The least amount of capital expenditure is intended for education and leisure (0.2%).

Current expenses mainly represent operational and financial costs, which are related to self-government activities. They will also be used to ensure effective digitization, e.g. electronic mail

distribution of various documents. The largest part (27.2%) is represented by education and leisure activities. The smallest part (1.9%) is represented by social aid and social services.

Table 4. Distribution of current budget expenditures by programs in 2024 (in %)

Education and leisure activities	27,2
Mobility and public transport	24
Order and safety	13,1
Effective and transparent self-government	13
Public infrastructure	7,7
Culture, sport, and tourism services support	6,8
Administration and management of city property	6,3
Social aid and social services	1,9

Source: Based on Hlavné mesto SR Bratislava (2023)

Based on the above data, Bratislava is mainly focused on improving the residents´ quality of life and communication, modernization of public services, business support, and tourism growth. Bratislava is trying to cope with financial restrictions, which, however, can burden residents and entrepreneurs with an increase in taxes and various fees. The city does not have the resources for investment projects, so it plans to reconstruct and modernize more.

4. BRATISLAVA ACCORDING TO THE IMD INDEX OF SMART CITIES

According to the International Institute for Management Development (IMD, 2023), the Smart City Index (SCI) was prepared for the year 2023, in which Bratislava was ranked 62nd out of 141 countries in the world. The rankings of the neighbouring countries capitals were as follows: Prague (Czech Republic) in 14th rank, Vienna (Austria) in 28th rank, Warsaw (Poland) in 44th rank and Budapest (Hungary) in 87th rank. Interestingly, Zurich (Switzerland) was ranked 1st, Oslo (Norway) 2nd and Canberra (Australia) 3rd.

15 indicators were applied in the assessment of Bratislava, out of which 5 indicators were assessed as the most urgent. The higher the score in a certain area, the more important the priority was, according to the respondents´ views. Table 5 shows the level of satisfaction of Bratislava residents, which is compared with the maximum score of 100.

The highest score of 67.8 out of 100 was received in the category "cultural activities in the city" (cultural events, concerts, shows, galleries, museums) in which respondents expressed satisfaction. In the category "work and education opportunities", satisfaction was expressed with an easily accessible job search (score 67 out of 100), with access to a good school for children (score of 64.2 out of 100), and with the creation of new jobs in companies (score 62.4 out of 100).

In the category "self-government" (score of 61 out of 100), satisfaction was expressed with easy access to information on the Bratislava's self-government decisions. In the categories "health and safety", satisfaction with recycling services and public safety achieved an average score.

In the category "availability of digital technologies in individual smart areas", the respondents were most satisfied with buying tickets online and facilitating access to cultural shows and events, concerts, galleries, museums, etc., (score of 78.5 out of 100). In the category "work and education opportunities" (score of 69.8 out of 100), the respondents also expressed satisfaction with online access to job advertisements to facilitate the job search, with the current speed and reliability of the Internet, which meets the users´ requirements.

Table 5. Smart city index assessment categories for Bratislava in 2023

Categories in which city residents expressed satisfaction with the provision of services based on the survey			Technologies, their availability and expression of satisfaction of city residents with the possibility of their use in individual categories		
1.	**Health and safety**	**Score out of 100**	**1.**	**Health and safety**	**Score out of 100**
	Meeting basic care needs in the poorest areas	57,6		Online reporting of city maintenance issues and quick resolution provision	48,3
	Satisfying recycling services in the city	57,4		A website that allows residents to share and donate unwanted items –re-using	51,5
	Public safety in the city is not an issue	58,2		Free public wifi has improved access to city services	55
	Air pollution is not a problem	37,5		Public security cameras make residents feel safer	52,9
	The provision of health services is satisfactory	42,4		A website or app allows residents to effectively monitor air pollution	36,8
	Finding housing with a rent that is 30% lower than the monthly salary is not a problem	25,2		Improving medical orders and visits online	60,8
2.	**Mobility**		**2.**	**Mobility**	
	Traffic jam is not a problem	22,2		Reducing traffic congestion, car sharing application	34,6
	Public transport is satisfactory	48		Applications for available parking lots and reduction of driving time	36,4
				Renting bicycles has reduced traffic jams	49,4
				Online timetables and ticket sales have simplified the use of public transport	66,7
				The city provides information about traffic jams via mobile phones	36,7
3.	**Activity**		**3.**	**Activity**	
	Green areas and spaces are satisfactory	40,5		Online ticket purchases for cultural shows, galleries, museums and more make it easy to attend	78,5
	Cultural activities (shows, galleries, museums) are satisfactory	67,8			
4.	**Opportunities - work and education**		**4.**	**Opportunities - work and education**	
	Job search is easily available	67		Online access to job postings to facilitate job search	69,8
	Most children have access to a good school	64,2		IT skills are well taught in schools	50
	Lifelong learning opportunities offered by local institutions	61		Online services provided by the city to facilitate starting a new business	38,1
	Businesses create new jobs	62,4		The current speed and reliability of the Internet meet the requirements of users	69,8
	Minorities feel welcome in the city	46,3			
5.	**Self-government administration**		**5.**	**Self-government administration**	
	Information about local self-government decisions is easily available	61		Online public access to city finances has reduced corruption	30,2
	Corruption of city officials is not a problem	28,8		Online voting increased the participation of residents	40,5
	Residents contribute to local government decision-making	40,1		An online platform where residents can propose their ideas, and proposals to improve life in the city	41,6
	Residents provide feedback on local government projects	50,7		Online processing of personal identification documents, applications, shortened the waiting time	54,5

Source: IMD Smart City Index Report (2023)

In the category "mobility" (score 66.7 out of 100), the respondents expressed the greatest satisfaction with the possibility of online tracking of the public transport timetable and online purchase of public transport tickets. In the category "health and safety" (score of 60.8 out of 100), the respondents were most satisfied with online orders for medical category examinations.

The respondents expressed dissatisfaction with the traffic situation and traffic jams in Bratislava. They also assessed as unsatisfactory the availability of easy and affordable housing with lower rent, the corruption of city officials, the car-sharing application to reduce traffic jams, the application for available parking lots, and the information provision about traffic jams via mobile phones.

5. FURTHER RESEARCH DIRECTIONS

Bratislava's long-term problem is the quality of public space, a place for activities and the movement of residents. It has been developing slowly and mainly thanks to private investment plans. The public space has been neglected for years, created without a concept and cooperation between the local government and the private sector, without consideration of the residents´ views related to their needs, and was non-progressive. The non-systematic approach provided opportunities for unregulated activities.

The solution of residents´ engagement is based on intensive awareness-raising activities about the conditions and qualities of public spaces, and the participation of the public and experts in their creation (through meetings with local self-government, presentations, workshops and surveys). The quality development of public space depends on smart and original solutions. Each of the 17 urban districts in Bratislava is locally diverse and specific, and the general approach is to preserve the unique character and unusualness of each of them.

The shortcoming was detected in the use of digital technology, information and communication technology, insufficient technical equipment and cyber security, and insufficient communication with residents via electronic mail. Civic engagement in public affairs is insufficient. The solution consists of the citizens´ online monitoring and online participation in the self-government meetings, online presence, and proposal submission via chats. The access to the proceedings of the self-government meetings will strengthen public control, the availability of resolutions on the website and the access to comment on self-government budget proposals and measures would make the operation of self-government more transparent.

The provision of safe, controllable and inexpensive communication between residents and self-governing bodies through ICT and digital technology and residents' access to these technologies would promote the implementation of the smart city concept. The electronic form of public administration communication with residents would bring advantages such as online communication from home, speed of online communication, and reduced travel costs or postage.

In the field of health care, there persists a shortage of medical personnel, and ambulances, unsatisfactory conditions in hospitals, outdated equipment and devices, and long waiting times for examinations by specialists, or operations, which threatens the medical services and health care quality provision. Quality housing is becoming even more unaffordable. The use of available building plots is insufficient and inefficient.

The long-term unused city buildings and industrial brownfields, mainly towards the city centre, could be gradually transformed into rental apartments, and apartments for socially vulnerable groups such as the homeless, the disabled, the socially dependent, or the housing for young families, reconstructed via the public-private partnerships projects.

6. CONCLUSION

Cooperation between the public sector, the private sector and residents is the key to the success and sustainable development of the smart city concept. Electronic communication between residents and public administration authorities is an important part. An important element of the smart city concept implementation is the provision of sustainable development and population growth. This includes the planning of the urban amenities, infrastructure and budgetary measures due to the prognosed population growth. The monitoring of population status and growth forecasts, together with migration and population aging, indicate the need for effective planning and management of city growth and development. Quality housing and accessible public transport are crucial for sustainable development. Big data files and trained human resources able to process them, and information and communication technologies for service improvement are the key management tools of smart city self-government.

In the paper, we examined the activities and the budgetary measures that Bratislava, developing a smart city concept, spends on the improvement of residents´ quality of life and the support of sustainable development. The effort to materialise the smart city concept is evidenced by projects and initiatives that are implemented in several areas. The integration of smart technologies and innovative solutions in the daily operation of the self-government would upgrade the efficiency of services and empower Bratislava's competitiveness at the national and international levels.

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