**SMART CITY - possibilities and limits**

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**Abstract**

The issue of smart cities is currently extremely topical, especially in the context of modern and democratic performance of self-government tasks. The demands of the population for the provision of quality services by the local government are constantly increasing. In this context, therefore, in this paper we deal with the issue of smart cities not only in terms of its theoretical definition and existing theoretical concepts, but also practical context. There are already quite a few of them, but their application is problematic in some Central European countries. Why this is the case, or what risks are associated with the implementation of the smart agenda on a practical level, will be the subject of this paper. Our ambition is to present this concept also in the light of current trends and challenges left to us by the coronavirus pandemic and, last but not least, our efforts to open a discussion on the form of modern self-government.

Keywords: Innovation, smart city, Europe, modern self-government.

**Introduction**

Smart city is a concept that has attracted a lot of attention in recent years due to its huge potential. Through its application, cities can not only increase the quality of life of their inhabitants but also support the business environment. Thanks to these activities, cities can reduce public spending and create savings for future needs. Smart city is the focus of a wide range of urban experts, scientists, city authorities and residents. This statement is also supported by the fact that more than 140 cities were interested in Smart City by 2013, and in 2014 the strategy for this approach was extended to more than 240 European cities [1]. These facts point to the relatively rapid spread of this concept. The aim of the paper is to provide a brief overview of the theoretical and practical context of the concept of Smart city. For this reason, the paper provides not only a definition of this concept but also a overview of the benefits that the Smart city application brings. On a practical level, the paper analyzes the position of the capitals of Central European countries in the IMD Smart City Index, which assesses the level of application of this concept.

**Literature Review**

In the European Union, Smart City is defined as a place where the usual networks and services are streamlined through the incorporation of digital and telecommunications technologies into their operation. This process benefits both the population and the business sector. Through the implementation of information and communication technologies, the city is making better use of resources and producing lower emissions. It is the integration of these technologies that improves and modernizes the transport network, lighting, water supply, building heating and waste disposal. All these innovations allow the city to respond more interactively and promptly to problems, increase the transparency of public procurement as well as better meet the needs of all sections of the population [2]. Smart city brings several benefits to its inhabitants. One of the most important aspects of housing not only in cities but also in other settlements is security. No person would choose to stay in places that do not guarantee their safety. Thanks to the rapid acceleration in the development of Smart cities, technologies such as CCTV (closed-circuit television) cameras can monitor everything around. CCTV is not a new technology, but it has been enhanced with features such as face recognition, license plates, smoke alarms, air quality measurement, door locking or unlocking, which makes it more efficient and reduces the risk of illegal activities [3]. In addition to these cameras, the addition of hotlines and panic buttons throughout the city, which sent police patrols to emergency situations, also improved security. This reduces the response time of the police, which in some situations could minimize or even eliminate catastrophic events [4]. The strategic factor that should be taken into account when planning a Smart city is whether the city can efficiently transport goods, services and people. Due to inefficient traffic, excessive traffic and dependence on cars, it is necessary to optimize travel with intelligent technologies and provide people with alternative options. One of these solutions are mobile applications, which provide an estimate of the time of trains, buses and other public transport. Applications should also provide time estimates for each route and provide an alternative mode of transportation. Another trend are electronic vehicles that eliminate emissions. Many states are creating "electricity grids" or large areas full of charging stations for electric vehicles to try to encourage greater use of electronic vehicles. Such intelligent transport reduces congestion and pollution in the city and can also have major benefits in terms of saving money and time [5]. A big advantage in many Smart cities is the ability to monitor traffic patterns and common traffic points by using sensors. The data collected informs about high volumes of traffic, dangerous areas or crossroads. Crossroads that are prone to accidents can be closely monitored and modified to facilitate traffic flow. In addition to improving traffic patterns, intelligent technology can also be used to monitor the environmental impact of traffic. The average vehicle speed in cities is currently 10 km/h, which means that drivers spend an average of 70 hours a year in a car. Smart cities with integrated infrastructures lead to better traffic management and thus faster and safer routes, so they could save drivers up to 60 hours a year. A more radical option is to reduce the use of private cars and replace it with car sharing technology. According to statistics, cars are idle 95% of the time, which means that each shared vehicle could effectively replace 10 to 30 private cars [6]. Participation in governance is also a benefit of implementing this concept. Citizens have on cities increasing demands. Civic participation is an important aspect that affects the development of the city. As a result, digital services are expanding to make the city more attractive to people and attracting new residents. In addition, access to public data, interactive maps, local government performance boards, live broadcasts of local councils and the active presence of social media help Smart cities promote relations between citizens and the local government. They help increase civic engagement and build trust in city officials [7]. Involving citizens in governance can mobilize society as a whole and bring many benefits. Cities with higher levels of government participation have stronger communities, better services and are more effective in tackling deprived neighborhoods [8]. In addition, the advantage of the application of the Smart city concept is also higher environmental protection. With the rise of global warming, greenhouse effects and street waste, cities are increasingly struggling to combat the adverse effects on the environment. Energy efficient buildings, air quality sensors and renewable energy sources provide an alternative to reduce environmental impact. Urban air quality sensors can help identify and monitor low air quality, identify the causes of pollution and provide data so that appropriate action can be taken [9]. A clear advantage of the application of the concept is also economic development, which is confirmed by analyzes according to which public investment in smart cities has 10 times greater potential to grow. As a result, as cities innovate, there will be massive growth in gross domestic product. Many private sectors are working with government officials to invest millions in smart city projects. Smart urban development plays an important role in increasing regional and global urban competitiveness in order to attract people and businesses. Providing an open data platform with access to city information helps businesses study citizens' interactions and activities and plan business strategies accordingly. The economic benefits of Smart city are therefore based on the ability of this concept to increase the city's productivity rate [10]. The Smart City concept should increase the economic development of cities by more than 5% by 2026 and bring economic benefits worldwide worth more than $ 20,000. The potential for building such cities lies especially in tackling urban inequalities. This means that such an approach allows the whole city to benefit from the economic development. The economic development of the city is also supported by its strategy in the field of communication and cooperation with companies. The city is trying to attract them with advantageous tax incentives, and at the same time such cities can share economic benefits through technology. With a growing number of businesses, employment in the city area is also growing and thus the quality of life of the inhabitants is increasing in direct proportion [11]. With more funds, the city has more opportunities to improve its infrastructure. Aging roads, bridges, buildings often require a large investment in maintenance during their lifetime. Smart technology can provide cities predictive analysis to identify areas that need to be repaired before infrastructure failures. Smart sensors can provide data showing changes in structure, identify cracks in bridges or buildings, and send messages that inform staff of the need for inspection and maintenance. In this way, they can help cities save huge costs and prevent infrastructure failures [12]. In addition, the Smart city concept also affects the efficiency of waste and water management. Part of increasing waste management efficiency is automated waste collection, in which sensors in collection containers signal that they are full and need to be emptied. Another example is the conversion of waste into energy and biofuels. Smart water is an infrastructure for water and wastewater that ensures that the water as well as the energy used to transport it are efficient. The problems that cities face in relation to water are, for example, the loss of water due to its leakage or overuse, insufficient water quality or the high energy consumption needed to move water and waste. The smart city involves solving water problems through smart water networks (SWGs), which allow water industry professionals to more accurately monitor the amount of water transported. And they ensure that it is not over-allocated to a certain area. At the same time, they provide information on water use and test water quality to ensure its safety and consumption [13]. Another solution is smart water meters, which, unlike manual water meters, have an increased ability to detect low water flow in the pipeline and potential block flow, which can cause problems with the operation of the water system. Other solutions include smart pumps and valves, which have access to environmental conditions and adjust their activity accordingly. Similarly, smart valves can adjust or block the flow in water pipes depending on what is needed. This significantly reduces the amount of water and energy wasted [14]. Finance for the city also indirectly brings cost savings, which is also one of the benefits of smart cities. Business and office sensors significantly increase the efficiency of public and commercial operations, which ultimately leads to huge cost savings. City councils in particular can have huge benefits from investing in smart city technologies, such as LED lighting, which can reduce city lighting costs. Thanks to immediate and long-term cost savings, the city is able to increase its budget in other key areas. At the same time, it can benefit from technology, such as the implementation of a road charging system that reduces parking fraud and uses data on urban infrastructure to find new ways of raising public funds [15]. Smart technologies in cities not only provide smart solutions and reduce costs, but also create new resources. Citizens can also benefit financially from Smart cities. The technologies reduce their costs for safety, heating, electricity, lighting and also water. Examples are home or accommodation sharing platforms that optimize housing utilization rates. Smarter and greener modes of transport, such as cycling or electric vehicle sharing, or travel-efficient applications, save people time and money. Citizens themselves also support the development of smart cities, saving each other money, for example through exchange applications and sharing-based platforms [16]. Last but not least, smart city initiatives, which prioritize people, residents and visitors, over everything else, tend to improve the quality of life in the city. Smart parking, efficient transport services, public Wi-Fi, digitized government, these technologies have a positive impact on citizens' lives because they make things more reliable and easier for them. The implementation of smart technologies addresses almost all areas of life, from housing to transport, health, education, environmental conditions to the public good. The quality of life of the inhabitants of Smart city increases in proportion to the implementation of various elements and types of innovation. It is directly linked to increasing security in the city, improving public transport, improving public services but also reducing the cost of living. Better public health is associated with a cleaner and more sustainable environment, and the city's social connectivity is strengthened through a wide range of cultural and leisure opportunities [4].

**Methodology**

The Smart city application therefore brings a number of benefits that improve and simplify the lives of the city's inhabitants. This is the reason why the process of implementing this concept has increased rapidly in recent years. It is being introduced by cities around the world as a solution to many challenges in the urban environment. The application level of the Smart city concept is assessed by the IMD Smart City Index. It was created in cooperation between the IMD (Institute for Management Development) and the Singapore University of Technology and Design (SUTD). In 2021, the third edition of the IMD Smart City Index was published and a total of 118 cities participated in this evaluation. The index evaluated cities on the basis of the attitudes of the inhabitants, who expressed their satisfaction and opinions on the city's infrastructure, technological support or existing technical services. At the same time, residents have identified areas that they perceive as the most problematic and which the city should primarily address.

We chose the capitals of Central European countries as the object of our survey. Within the IMD Smart City Index, we analyzed the level of Smart city in the capital of Switzerland, Austria, Germany, Poland, the Czech Republic, Slovakia and Hungary. Despite the fact that from the point of view of economic indicators, such as GDP (Table 1), these are countries that are at a diametrically different level, from a geographical and political point of view they are united by the fact that they belong to Central Europe. The obtained data on the level of Smart city in selected cities were subsequently evaluated using the method of comparison.

**Tab. 1 Central European countries' GDP**

|  |  |
| --- | --- |
| **Country** | **GDP** |
| Schweiz (Zurich) | 752,25 bilion USD |
| Austria (Vienna) | 433,26 bilion USD |
| Germany (Berlin) | 3 850 bilion USD |
| Poland (Warsaw) | 596,62 bilion USD |
| Czech republic (Prague) | 245,34 bilion USD |
| Slovakia (Bratislava) | 105,17 bilion USD |
| Hungary (Budapest) | 155,81 bilion USD |

Source: Own elaboration [17]

The following Figure 1 shows the capitals of selected countries in the IMD Smart City Index. The graph provides information on the position of cities during 2019, 2020 and 2021. In 2021, naturally the best ratings were given to cities in economically strong countries such as Switzerland, Austria and Germany. Zurich is even one of the world's top smart cities. It was followed by Vienna, which is similarly at the forefront of the index. Other cities were on lower ranks, such as Prague in 78th place or Budapest in 97th place. When we look at the comparison of positions within selected years, it is possible to observe in most cases deteriorating trends in the quality of Smart city. The worst evaluation is achieved by Prague, which has fallen by almost 60 places since 2019. The improvement curve can only be observed in Vienna, while Zurich is still moving at about the same position. Following the GDP of the countries, it is also possible to observe a parallel between economic strength and the development of the Smart city concept. Naturally, the best evaluation of the application of the concept is achieved by countries with higher GDP and countries with lower GDP value, such as the Czech Republic, Slovakia and Hungary are in worse positions in the ranking.

**Fig. 1 Smart city ranking by IMD**

Source: Own elaboration [18]

The capitals of Central Europe are therefore in relatively different positions within the quality of Smart city. The inhabitants of these cities in the IMD index also evaluated the priority areas, which according to them are problematic and the city authorities should deal with them primarily. Thus, despite the differences, some similarities can be observed in Table 2. First of all, it is a problem of housing affordability that all cities face, regardless of the level of Smart City or GDP. Housing affordability is currently a problem for all major cities, which are unable to meet housing demand due to massive urbanization. In the second line of the table, the opinions of the inhabitants differ with regard to the individuality of each city. Traffic congestion is a problem for the people of Zurich, Prague and Bratislava, health services are a problem for the people of Warsaw and Budapest, unemployment is a problem for the people of Vienna and safety is a problem for the people of Berlin. The third line points to the problem of air pollution and corruption in the city administration. Subsequently, most problems recur or have associated problems. However, the order of the problems is individual depending on the selected city. An interesting fact is that in such developed cities as Berlin or Warsaw, residents still face the problem of unavailability of basic civic amenities.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Zurich** | **Vienna** | **Berlin** | **Warsaw** | **Prague** | **Bratislava** | **Budapest** |
| 1. | affordable housing | affordable housing | affordable housing | affordable housing | affordable housing | affordable housing | affordable housing |
| 2. | road congestion | unemployment | security | health services | road congestion | road congestion | health services |
| 3. | air pollution | road congestion | road congestion | air pollution | corruption | health services | corruption |
| 4. | unemployment | security | unemployment | fulfilling employment | air pollution | green spaces | security |
| 5. | security | air pollution | air pollution | road congestion | green spaces | corruption | air pollution |
| 6. | green spaces | corruption school | school education | security | security | public transport | fulfilling employment |
| 7. | recycling | school education | public transport | basic amenities | citizen engagement | air pollution | road congestion |
| 8. | fulfilling employment | citizen engagement | basic amenities | green spaces | social mobility | recycling | green spaces |
| 9. | public transport | health services | recycling | public transport | fulfilling employment | security | unemployment |
| 10. | social mobility | green spaces | health services | recycling | public transport | fulfilling employment | public transport |

**Tab. 2 City problems**

Source: Own elaboration IMD Smart City Index 2021

**Discussion**

Previous data point to the fact that economically stronger states dominate the application of the Smart city concept. Specifically, these are countries which, in terms of economic strength, declare themselves to Western Europe, but are part of Central Europe on the basis of a geographical criterion. Zurich, Vienna and Berlin are in the first half of the IMD Smart City Index. Their economic strength allows them to spend money on the development of areas, which involves a large number of costly innovations. Interesting is the fact that the German capital, Berlin, despite the highest GDP, has the worst rating among the three countries. Other countries, such as Slovakia, Hungary, the Czech Republic and Poland, still do not reach the level of their neighbors in the Smart city concept.

Despite the differences in the economic situation, the countries have also faced a major challenge in the last two years in the form of the COVID-19 pandemic. It had a big impact on society as a whole. Its arrival has disrupted the functioning of the public and complicated the achievement of goals not only in the field of Smart City [19]. Large cities have been hit harder by its negative consequences, as they are the centers of the accumulation of large numbers of people. This has allowed the virus to spread faster and more massively, thus worsening the functioning of cities [20]. Proven and established practices have suddenly become unusable and funding has been channeled into critical areas [21]. The Smart city agenda has thus moved to the background, which has also been reflected in the assessment, in which all cities, with the exception of Vienna, have seen a deterioration in the IMD Smart City Index.

In addition to the pandemic, which has hit cities of all sizes, the capitals are united by the fact that they face the same challenges in many areas. Among the most serious is the availability of housing, which dominates in the first place in all cities. It is followed by a bad traffic situation and the associated traffic jams, which complicate the lives of the inhabitants of big cities. In addition, the level of healthcare, air pollution, corruption and security is also a problem.

The survey shows that the capitals of Slovakia, Hungary, the Czech Republic and Poland show a weaker assessment of Smart city. This fact can be caused by several aspects. The implementation of the Smart concept brings with it a number of challenges that must be addressed at the local and national levels. These challenges include, for example, designing a strategy, which has a defined clear benefit for stakeholders. It is important and necessary that the strategy is based on real needs and requirements. At the same time, a successful strategy is a strategy that addresses and reflects the needs and vision of the local community, including focusing on the customer, improving the quality of life and providing a competitive advantage for businesses that foster positive growth. A good strategy should be able to quickly identify the initiatives that bring the most benefits. The strategy thus created creates a strong cohesion of stakeholders. The strategy must be comprehensible so that its purpose is understood not only by city officials but also by the citizens themselves. The advantages and benefits of implementing Smart city may not be as obvious as "tape cutting" for a new bridge, building or road. As a result, it is important that the implementation of smart projects includes examples and results that are easily understood by citizens and businesses. Public information is key to supporting initiatives and reminds staff and the public of the main reasons for implementing projects [22].

The decisive factor in the success of the Smart city concept is the involvement of a wide range of actors, from regional agencies, through companies, residents to various other institutions. Timely and high-quality stakeholder involvement and strong connections with the population can put the city in a leading position in competitiveness. It is therefore important to create an inclusive society and to involve all parts of the city in decision-making and management. Another approach to achieving the goals as quickly as possible is to build on what has already been done. Cities already have a lot of innovation in place, but the problem is that they don't inform and share these innovations. Developing communication and marketing around what is already being done creates awareness, pride and a foundation on which to build for the future [23].

Due to the rapid pace of technological change, many short-term projects may ultimately look completely different from what was initially expected. We can often see the consequences of rapidly incorporating technology into a city's development without thinking about the impact on the population. These are technologies that have not been planned or coordinated with other departments of the city. Therefore, it is important that smart intentions are communicated with all stakeholders and city departments and that they are implemented thoughtfully and with a long-term vision that knows all the risks and benefits [22].

Another challenge is the issue of privacy and digital security. Technologies simplify life and provide access to large amounts of data and information. However, the flow of data must respect the principles of privacy and personal freedom. This challenge is a very sensitive aspect of implementation, as a large amount of personal data and important information flows through the Smart city system. It is a large amount of information, which includes, for example, personal data or the movement of inhabitants within the city. For this reason, transparency in the use of such information is important, as is safeguarding against cyber attacks and their possible misuse [24].

Creating a smart city is a long-term affair. The city does not become Smart after the application of one or more projects, but only when its concept and operation correspond to the idea and vision of this concept. The big challenge of implementation is finance, which is a key factor in whether and what strategy will be implemented. As we mentioned above, the initial costs of implementing large-scale technologies are very high and ensuring sufficient resources throughout the projects is investment-intensive. Among other things, everything depends on the inhabitants of the city and their flexibility, ability to adapt, but also the willingness to change the usual ways of functioning.

**Conclusions**

The implementation of the Smart city concept is a modern trend of all major cities. Its benefits are unmissable and can make life in cities easier and better. Examples can be more efficient transport and economic development and also higher participation of the population, higher employment or cost savings. When analyzing the implementation of this concept in the capitals of Central Europe, it can be observed that countries with higher levels of GDP dominate in the IMD Smart City Index, namely countries such as Germany, Switzerland and Austria. The COVID-19 pandemic has had a major impact on the development of states and the Smart City concept in the last two years. This limited the development of the implementation of Smart City, and its consequences were reflected in the evaluation of cities.

Despite the relatively large differences in the economic situation in the countries of Central Europe, it can be stated that the capitals suffer from the same problems and are exposed to the same challenges. The dominant problem is the availability of housing, after which cities face problems such as traffic jams, air pollution and corruption. The survey also pointed to the evaluation of Smart city in the capitals of Slovakia, Hungary, the Czech Republic and Poland, which are located at the lower ranks of the Smart City Index. There may be several reasons why these countries have lower scores. The implementation of the Smart city concept faces several challenges that affect its quality. Examples include designing a real strategy, involving a wide range of actors, prediction or privacy. These can all be constraints that cause cities to be weaker in their Smart City ratings. Nevertheless, it is necessary to keep in mind that the concept of Smart city is a time-consuming and, above all, long-term matter. This is also a key assumption that future developments are difficult to predict and the potential of capitals suggests that their assessments will change in the future.

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