

## SMART CITY CONCEPT WITHIN SELECTED COUNTRIES

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**Abstract:** This manuscript deals with the issue of the Smart City concept in the capitals of selected European countries, which are the Slovak Republic, the Czech Republic, and Austria. This scientific manuscript defines technical terms such as Smart city and also the whole concept of the Smart City. An overview of Smart City services is also presented. The analysis of the current state of the article is focused on the Index Cities in Motion 2018 which evaluates the current development concept of a Smart City in selected major cities such as Vienna, Prague, and Bratislava. Based on the analysis, we wanted to verify whether the Slovak Republic is ranked in the first half of the surveyed countries within the Index Cities in Motion. This hypothesis has been confirmed. Within these selected capital cities, we focused on mobile applications, which are provided under the three chosen areas of the concept of a Smart City such as transportation services, environmental services, and real-time localization services. Subsequently, we found that most applications in the countries under review are implemented in the transport sector. Subsequently, we focused on the number of downloads and the cost of each app. We've also researched apps through Google Play. Based on a detailed analysis, we defined the advantages and disadvantages of the three most frequently used areas of the Smart City concept.

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### Introduction

The term “Smart City” can be defined as a Smart City which uses modern and intelligent technologies that facilitate energy saving, increase the standard of living and also saves the environment. In practice, a Smart City can be defined as the implementation of modern technologies to save energy, improve awareness and increase the speed of civic engagement in the city. The implementation of new smart technologies requires the cooperation of the public sector, industry, education, and NGOs of the city. The concept of a smart city aims to build social as well as technological infrastructure that accelerates economic growth. The concept of a smart city has the task of the building and development of public infrastructure, local roads, public lighting, cycle paths, waste treatment solutions and the operation of public buildings. These activities help to increase the standard of living of the population, to improve the overall management of the city and to regulate the negative impacts on the environment.

#### Overview of intelligent city services

The concept of a Smart City offers a wide range of individual services and applications that can be used in everyday life. In the Table 1 there is displayed in which areas it is possible to use the concept of a smart city and smart services that can be provided.

The Table 1 shows services that cover areas such as transport, utilities, education, health and social care, ecology, and public security. The development of individual applications and services are extended to various areas to assist citizens in everyday life. To realize these services, it is necessary for individual cities to secure a smart grid, smart home, the location of individual applications, mobile payment and so on.

Smart city projects are funded at the national and international level. At the international level, the European Union supports the development of smart cities through various grants. Another international aid for the development of smart city projects is the European Investment Bank, which has been contributing a certain percentage for 20 years. At the national level, the funding of these type of projects is dealt with by individual ministries and competent authorities, which are dealing with smart city development contributions in that country.

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Table 1: Overview of intelligent city services	
Description	Examples of use
<b>General business services</b>	
Establishing relationships between city and partners to deliver value-added services to stakeholders	<ul style="list-style-type: none"> <li>• smart shopping</li> <li>• e-shopping</li> <li>• easier access to the labor market for citizens</li> </ul>
<b>Smart buildings</b>	
Smart buildings take benefits from the integration of communications and management systems	<ul style="list-style-type: none"> <li>• optimized air conditioning,</li> <li>• management of general facilities</li> </ul>
<b>Education, health care and social services</b>	
Creating applications that help to improve processes in these areas. These applications also provide better access to individual services	<ul style="list-style-type: none"> <li>• telemedicine</li> <li>• sharing medical records</li> <li>• tracking systems for elder people</li> <li>• virtual exhibitions and lectures</li> </ul>
<b>Energetics Smart lighting</b>	
Intelligent electronic systems that connect power networks	<ul style="list-style-type: none"> <li>• lighting control system</li> <li>• smart grid apps</li> <li>• optimize network performance</li> <li>• compliance monitoring</li> </ul>
<b>Smart Grid, measurement of gas, water and electricity</b>	
Smart measurings that record the use of energy, water, and gas for a certain unit of time	<ul style="list-style-type: none"> <li>• wireless communication for smart metering</li> <li>• on-line consumption information</li> </ul>
<b>Smart Utility, Water and sewer network</b>	
Smart water and sewage management	<ul style="list-style-type: none"> <li>• smart sewer system</li> <li>• waste bin monitoring</li> <li>• water network management system</li> <li>• compliance monitoring</li> </ul>
<b>Transport services</b>	
Smart transport solutions	<ul style="list-style-type: none"> <li>• bike-sharing</li> <li>• applications for reporting potholes</li> <li>• taxi-calling apps</li> <li>• applications to reserve a parking spot in downtown</li> </ul>
<b>Environmental policy</b>	
Green solutions implementing through smart devices	<ul style="list-style-type: none"> <li>• waste and recycling apps</li> <li>• applications for air quality control</li> <li>• electric car ordering apps</li> </ul>
<b>Public security and crime</b>	
Early warning system for citizens. Optimizing emergency response time and capacity	<ul style="list-style-type: none"> <li>• city video surveillance system</li> <li>• IP monitoring system</li> <li>• distress signal</li> </ul>
<b>Real-time localization of services</b>	
Providing reasonable information for the needs of citizens	<ul style="list-style-type: none"> <li>• strategic placement of city-dashboard with substantial information for citizens</li> </ul>
Source: Author	

### Analysis of an intelligent city in selected countries

The analysis of the current situation deals with the concept of the Smart City in countries such as the Slovak Republic, the Czech Republic, and Austria. These countries were chosen because of a similarity that is closest to the conditions of the Slovak Republic. In these selected countries, we focused only on capitals. We analyzed in detail the Index Cities in Motion, which gave us an insight into the current state of the smart city concept.

#### Index Cities in Motion

The Cities in Motion 2018 Index evaluates 165 countries around the world based on nine key areas. The Index Cities in Motion is conducted by the Business School of Navara, Spain annually.

The areas of the index under review include:

1. The Economy– main indicators are GDP and the number of large international companies based in the city.
2. Human Capital– in this area is mandatory the education of the population itself, the number of university specialists, etc.
3. Social Cohesion – this area focuses on monitoring crime, unemployment and the quality of health care in individual cities.
4. Environment – main indicators in this area are air quality, efficient use of water, reducing emissions and so on.
5. Governance– in this area is monitored expertness of city councilors, communication of the municipal council with the inhabitants themselves, a publication of self-government contracts, etc.
6. Urban planning– main parameters of this area are the evaluation of the construction of infrastructure and the monitoring of public transport.
7. International outreach– in this area the promotion of the city are monitored, as well as holding international congresses, visiting the city by foreign tourists, etc.
8. Technology– the main indicators of the area include monitoring the city's popularity through social networks, the number of places with free Wi-Fi connections, etc.
9. Mobility and transportation– the density of the transport infrastructure network is overviewed.

The table shows the individual rankings of countries within the monitored areas. Countries score points from 1 to 165. The lower the value, the better place for the country. As an example, the capital city of Bratislava reaches the 74th position in Terms of Economy among the 165 countries surveyed. These positions in each area are important to determine Cities in Motion Index (CIMI). The value of the resulting index CIMI ranges from 0 to 100 points. The higher the index, the better the overall position of the country. The city that reaches 100 points has the best ranking.

In the Table 2 we can see the score of the capitals of selected countries in the individual areas of the Index of Cities in Motion of 2018.

Index of Capital Cities in Motion of 2018			
Monitored area	Vienna(A)	Prague (CZ)	Bratislava (SK)
Economy	72	82	74
Human Capital	31	61	81
Social cohesion	36	31	16
Environment	18	23	32
Governance	18	60	42
Urban planning	41	94	64
International outreach	8	27	90
Technology	23	18	131
Mobility and transportation	14	66	91
CIMI	<b>71,51</b>	<b>63,85</b>	<b>56,18</b>
<b>Cities in Motion</b>	<b>19</b>	<b>40</b>	<b>67</b>

Source: Author

The table shows the ranking of selected countries in the Cities in Motion 2018 index. Vienna, the capital of Austria, achieved a total score of 71.51 points, which means that the score was ranked 19th out of the 165 monitored countries. In the Czech Republic, the capital city of Prague is ranked 40th out of the 165 countries surveyed. Prague achieved a total score of 63.85 points in the monitored index. Another selected country was Slovakia with the capital city of Bratislava. This city of Bratislava is ranked 67th out of 165 evaluation countries and achieve a total score of 56.18 points. Finding that the Slovak Republic ranked 67th out of 165 countries, we can conclude that the Slovak Republic rank is in the first half of the countries under review.

The analysis of the concept of the Smart City in selected countries, according to the Index Cities in Motion showed that Austria is the best country. Vienna has achieved the best results in terms of economy, suggesting that the city is home to a large number of international companies and that the GDP is also higher than in other countries. The worst area in which Vienna should improve the score is International outreach. In this area, Vienna should improve the promotion of the city, organize more

international congresses, etc. The Czech Republic is the second-best country among the selected countries. The City of Prague received the highest score in the Urban planning area because it has a very well built transport infrastructure. The worst score was achieved in the Technology area, where it would be necessary to focus on increasing the number of places with free Wi-Fi, etc. The last country among the selected countries is the Slovak Republic. The capital city of Bratislava achieved the best score in the field of Technology, which means that the city can present itself through social networks and is technically proficient to implement the smart city concept. The worst ranking area of Cities in Motion is Social cohesion. Bratislava should concentrate on improving the quality of health care, reducing crime in the city and so on.

### **Methodology**

In this article, we implemented a professional definition of what is a Smart City and the Smart City concept along with an overview of smart urban services. Subsequently, we carried out an analysis of the current situation through monitoring the Index Cities in Motion, which monitors the current state of the concept of Smart City in selected countries.

The result of this article is a private analysis which is focused on mobile applications which are used by citizens and can be used in the capitals of selected countries. Those mobile applications are divided into three groups. Based on the private analysis, we deduced the individual advantages and disadvantages of the selected areas of interest and made individual recommendations for the smart city concept.

### **Results**

In the practical part, we focused on three areas where individual mobile applications are most often provided within the Smart City. These three main areas are Transport Services, Environmental Services, and Real-time Services Localization. In the Table 3 we can see what specific mobile applications are used in Bratislava, Prague, and Vienna.

The table shows specific applications that are most often used in the selected capitals within the Smart City concept. We have found that individual applications are most often used in the field of transport services.

After the comparison, we found that the city of Bratislava uses applications for monitoring the current location of public transport, finding the fastest connection or to download a discount card into an application. In the area of services, the city Prague uses applications which provide citizens maps of the road public transport, cycle paths or can report a damaged road. The city of Vienna uses applications which provide citizens the possibility to purchase a ticket for integrated transport as well as to obtain information on the nearest connection and timetable. Other apps give citizens the option to rent bikes in the city center.

Individual capitals of the selected countries within the concept of Smart City also cover environmental services, which help to improve the environment.

An application has been created for citizens in the city of Bratislava. The application helps to classify an unknown plant into the respective species. Another application in the field of environmental services is the application for waste sorting. By taking pictures of the waste into the application, it is possible to find out how to sort the waste. Another application has been created in the city of Prague that provides citizens with an order for an electric car ride. Another application is provided in the city of Vienna to gather information on the waste collection dates. Another application provides information about the nearest eco-shop for the user of the application.

Another area of focus is localization services in real-time. These services provide up-to-date information that individual citizens can use in their daily lives.

Through these applications, citizens of Bratislava can report broken lightings, building damage, etc. Another application provides up-to-date information about individual restaurants, hotels, public events, etc. In the city of Prague are created applications which provide citizens with an online city guide, information about the possibility of a trip or information about the opening hours of the pharmacy, medical facilities, etc. In the city of Vienna, real-time location services are provided with applications that give up-to-date information on individual hotels, cafes, and shops that are closest to the user of the application. Another application allows you to book a hotel or table in a restaurant for a specific time.

Table 3. Applications in individual areas of interest		
Transport services		
Bratislava	Prague	Vienna
<p><b>Hopin app</b> provides citizens to track the current location of public transport.</p> <p><b>UBIAN app</b> provides citizens the best possible transport links to their destination as quickly as possible.</p> <p><b>BMK digital</b> provides option to download of public transport card and then citizen can use necessary discounts.</p>	<p><b>DopravaPubtran</b> provides citizens a map of the connection and the most suitable public transport connection.</p> <p><b>Na kolePrahau</b> provides the best cycling trails and routes in Prague.</p> <p><b>Zmeňte to</b> provides the ability to report damaged roads and sidewalks, by taking a picture of a problem.</p>	<p><b>Smartphone “Wien Mobil”</b> provides train, bus and tram schedules</p> <p><b>CityBike Wien</b> bike-sharing application</p> <p><b>Wiener Linien Ticket App</b> this application allows to buy a ticket for the integrated transport system</p>
Environmental services		
Bratislava	Prague	Vienna
<p><b>PI@nt Net</b> By using a camera app can get recognized to what species the plant belongs to.</p> <p><b>Green Bin</b> If you take a picture of trash, app can tell you how to recycle it.</p>	<p><b>Lítačka</b> Through this app, a citizen can order an electric car for a ride to support emission reduction.</p>	<p><b>APP MA 48</b> Information about waste disposal schedule.</p> <p><b>Map TREEDAY</b> Application for environmental friendly retails. The application also helps to lower the exhaust gases by monitoring the ways of transport used by citizens.</p>
Real-time services localization		
Bratislava	Prague	Vienna
<p><b>City Monitor</b> Citizens can take a picture of malfunctioning public lighting, graphite on building, etc. The photo will be sent to the local authority that will resolve the issue.</p> <p><b>Bratislava región</b> provides citizens up-to-date information about restaurants, hotels, public events in the city.</p>	<p><b>Prague Visitor Guide</b> This app provides up-to-date information about monuments, restaurants, hotels, public toilets and so on.</p> <p><b>Prague Travel Guide</b> Provides tips and information about trips in Prague.</p> <p><b>AplikáciaMoja Praha</b> Provides citizens actual information about opening times of individual offices, pharmacy, medical facilities, etc.</p>	<p><b>Susi</b> City guidance application.</p> <p><b>Quando</b> Application for restaurant booking.</p>
Source: Author		

The Table 4 shows the name of the app, the average monthly number of apps downloaded, the number of apps downloaded since the launch date, the launch date, and their price. In the Table 4, apps are ordered from the highest average monthly app downloads to the lowest in a city. The average monthly number of downloads per month has been found over the period since the app was created in 2019.

The table shows that the most downloaded application in Bratislava is PI @ nt Net. This application has been downloaded on average 84,746 times in the month since the application was created. In Prague, on average, the most downloaded app in a month is the Traffic Pubtran app, which is downloaded up to

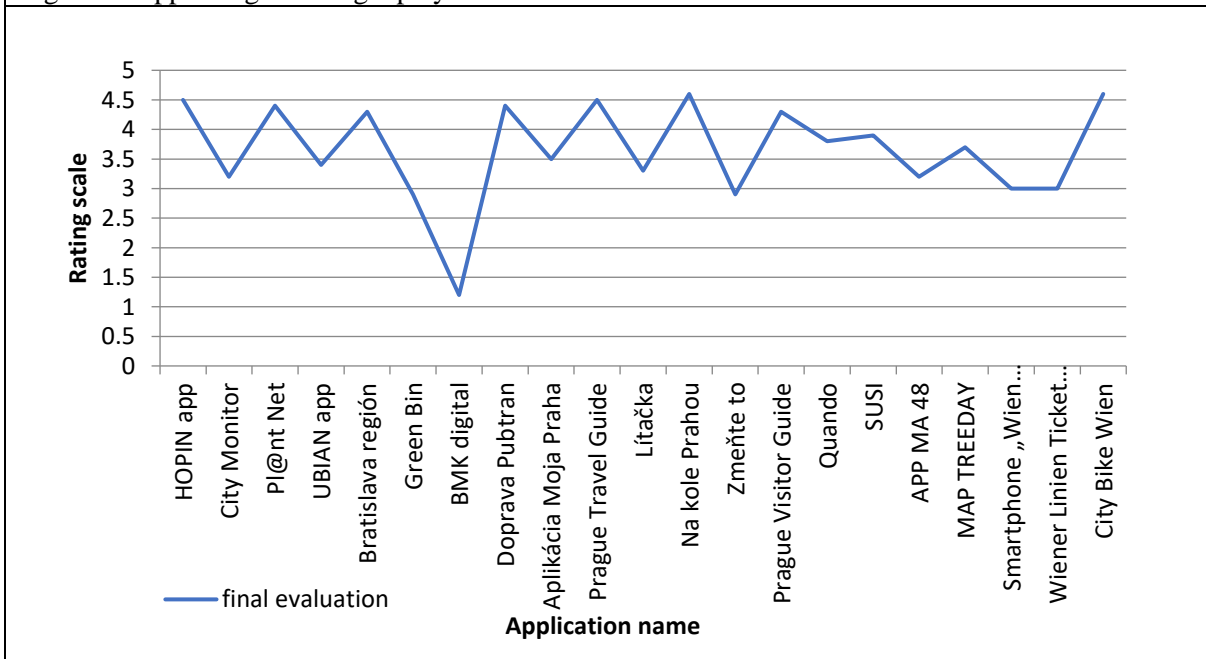
4,673 times a month. Even though the total number of downloads since the app was created is only 500,000, this app has won the lead. On average, the city of Vienna downloads the Quando app most on average per month. On average, users download it up to 10,102 times a month. It is the only application which is also paid. The price for an item is 2.79 € - 59.99 €. It depends on the version of the application.

Table 4. Detailed information about each application.

Application name	Average monthly downloads	Number of downloads	Date of formation	The price
<b>Bratislava</b>				
Pl@nt Net	84 746	5 000 000	21. 01. 2014	Free
UBIAN app	1 852	50 000	29. 09. 2016	Free
HOPIN app	1 370	100 000	06. 11. 2012	Free
Bratislava región	152	5 000	11. 03. 2016	Free
City Monitor	62	5 000	20. 03. 2012	Free
BMK digital	42	500	06. 02. 2017	Free
Green Bin	31	1 000	01. 03.2016	Free
<b>Prague</b>				
DopravaPubtran	4 673	500 000	28. 01. 2010	Free
Lítačka	3 572	100 000	20. 08. 2016	Free
Prague Travel Guide	1 725	100 000	14. 02. 2014	Free
AplikáciaMoja Praha	725	50 000	16. 03. 2013	Free
Na kolePrahou	477	10 000	28. 03. 2017	Free
Zmeňte to	417	5 000	20. 12. 2017	Free
Prague Visitor Guide	84	1 000	20. 12. 2017	Free
<b>Vienna</b>				
Quando	10 102	1 000 000	03. 09. 2010	2.79 €- 59.99 €per item
Smartphone „Wien Mobil	3 125	100 000	28. 04. 2016	Free
Wiener Linien Ticket app	3 125	100 000	29. 04. 2016	Free
SUSI	625	50 000	17. 04. 2012	Free
City Bike Wien	625	10 000	26. 08. 2017	Free
APP MA 48	193	10 000	04. 08. 2014	Free
MAP TREEDAY	129	5 000	27. 09. 2015	Free

Source: Author

Figure 1. App rating on Google play



Source: Author

We found out ratings for individual apps through Google Play. The rating scale is from 1 to 5. The higher the score, the better the app. In the Figure 1, we can see the average rating of individual applications.

The chart shows that the best app that received the best rating on Google Play is City Bike Wien, while BMK digital received the worst rating.

Like various research areas, the Smart City concept has certain advantages and disadvantages in the individual areas of study. For this reason, we have carried out a detailed analysis of the individual advantages and disadvantages of the smart city concept in these areas.

Advantages and disadvantages of transport services

The advantages of transport services include:

- getting up-to-date information,
- saving travel time by searching for the fastest transport connection,
- making the timetable more transparent,
- participation of citizens in improving the city.

The disadvantages of transport services include:

- high cost and cost of complexity in implementing the applications,
- the citizen of the city must be connected to the Internet, be online.

Advantages and disadvantages of environmental services

The benefits of environmental services include:

- contributing to the improvement of the environment,
- assistance for sorting waste,
- the using of electric vehicles for reducing emissions,
- reducing the amount of poorly sorted waste,
- promoting the sale of eco-products.

Disadvantages of environmental services include:

- high cost and complexity in realizing the applications,
- the citizen must be connected to the Internet, they must be online,
- when using waste sorting applications, they must scan each item of waste separately on the phone.

Advantages and disadvantages of Real-time service localization

The advantages of Real-time services localization are:

- getting up-to-date information,
- citizens participation in improving the city,
- obtaining information on leisure activities,
- getting to know the city's culture,
- better orientation in the city.

The following disadvantages of real-time service localization include:

- high cost and complexity in realizing the applications,
- individual apps are targeted to specific parts of the city,
- the citizen must be connected to the Internet, so they must be online.

The smart city concept brings various advantages and disadvantages. Based on the above-detailed analysis of the area of interest, we have found that the Smart City concept has several advantages. For this reason, it is necessary to realize and participate in the realization of modern digital cities that will help citizens in everyday life.

## Conclusion

The Smart City concept is a modern way to modernize individual cities and move closer to digitalization. This is a broad concept and therefore has extensive engagement possibilities of the different services in different areas. To realize such a modern city, cooperation must be made from various parties, whether they are experts in IT, research organizations, the government of the country, or the European Union. The basis for creating a smart city is to obtain information from citizens who should be involved in

implementing such a concept. It is important to create cities that will serve citizens in raising their standard of living, improving the overall economy of the city and regulating negative environmental impacts.

In the analysis of the current state, we followed the Index Cities in Motion 2018, which evaluates the individual areas that are involved in the development of the concept of the Smart City. From among the selected countries, we found that the best location was awarded to the capital of Austria, or Vienna. This capital scored an overall score of 71, 51 points, representing 19th place among 165 countries.

As part of realizing the analysis of private capitals in the selected countries, we think that the use and sharing of realizing the concept of the Smart City is positive. These countries are trying to implement new ways in which they can contribute to the development of the digital city. Use of different service applications that people use and which are also useful for their daily lives. Compared to other foreign countries, these countries are still at the beginning of the concept of the Smart City. At the same time, we must state that their progress is visible and consequently the development of the Smart City concept in the countries concerned must be continuously supported.

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