Bielsko-Biała

Contents

Smart city – elements of innovative solutions in Bielsko-Biała

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Abstract— **The aim of the study is to present the concept of smart city as the direction of city development. The concept of a smart city is currently one of the many aspects of the city's strategy implemented by local governments. Modern solutions make it possible to effectively carry out public utility tasks, which results in improvement of the lives of the inhabitants of a given local community. The author presents examples of the implementation of smart city elements in Bielsko-Biała. Conclusions: the innovative technologies implemented in Bielsko-Biała so far, as in many other medium-sized Polish cities, are not particularly comprehensive. These are individual improvements that positively affect the quality of life of residents, improve the natural environment and reduce public spending.**

Keywords— **smart city, city development, intelligent city, quality of life.**

I. INTRODUCTION

Nowadays, progressing process of urbanization can be seen: the role of cities as the main centers of life which gather an increasing part of society within them, is increasing in the modern world. As a consequence, city authorities are faced with the challenge of guaranteeing an adequate standard of life and living conditions for their inhabitants. This creates the need to design thoughtfully managed, constantly developing and future-oriented cities. The aim of the study is to present the concept of smart city as the direction of a sustainable city development. Promoting innovation and entrepreneurship allows the creation of new jobs and globally competitive economies. The concept of smart city aims towards creating sustainable cities, i.e. those in which resource saving concerns not only economic and social aspects, but also the environment and public space. It is therefore worth improving the management of cities and increasing flexibility in gaining access to new resources. The article will present the implementation of smart city elements in Bielsko-Biała, which is successfully trying to adapt the idea to its capabilities.

II. IDEA OF SMART CITY

The term "smart city" has many different definitions, but most scholars and experts define this term as "a city with a development strategy which focuses on flexibility, openness to innovation and creativity, which is understood as the ability to quickly adapt to new external and internal conditions" (PKN, 2022). Smart cities base their strategy on the use of Information and Communication Technologies (ICT) in areas such as economy, environment, mobility and governance. It is all used with an aim of improving the standard of living of residents and increasing their participation in decision-making process (PKN, 2022).

According to A. Caragliu (2020), a city is considered smart when it invests in human and social capital and in traditional and modern communication infrastructure (ICT) in order to achieve sustainable economic development and high quality of life, along with responsible management of natural resources. On the other hand, IBM defines smart city as using ICT to understand, analyze and integrate key information in the basic city development system (Lekamge, Marasinghe 2013). For Northstream, the smart city concept is a connection between people, objects, tools, etc. by using omnipresent technologies to improve living conditions in the 21st century urban environment. On the other hand, P. Dameri points out that a smart city is a specific geographic area in which high ICT technologies, logistics, energy, etc. are included in cooperation in order to generate benefits for residents. Cooperation here takes into account quality of life, inclusion and participation,

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the environment and intelligent development. Smart city is managed by entities that set the rules and policy of city management and development.

It is assumed that a smart city is one that is characterized by (Korneluk et al. 2019):

- smart economy, i.e. a highly efficient and technologically advanced economy thanks to the use of ICT; an economy which develops new products, services and new business models; favors the establishment of local and global connections and the international exchange of goods, services and knowledge;
- smart mobility networks, i.e. integrated transport and logistics systems, mainly using clean energy;
- sustainable use of resources (smart environment); smart city uses natural resources sparingly; it aims towards increasing the use of renewable energy sources; electricity networks, water, street lighting and other public services are controlled in a way that optimizes the environmental and financial costs of their operation; ongoing measurement, control and monitoring of pollutants is carried out; buildings are renovated to reduce their energy consumption;
- high-quality social capital (smart people), the creation of which is possible in the conditions of social diversity, tolerance, creativity and dedication;
- high quality of life (smart living), meaning a safe and healthy life in a city with a rich cultural and housing offer, which ensures wide access to ICT infrastructure which enables the formation of lifestyle, behavior and consumption;
- smart governance, i.e. governance which puts an emphasis on: social participation in decision-making, also of a strategic nature, transparency of operations, quality and availability of public services (Nam i Pardo, 2014)

The following steps can be distinguished in the development of smart cities (Fig. 1):

FIG. 1. LEVELS OF DEVELOPMENT OF SMART CITIES
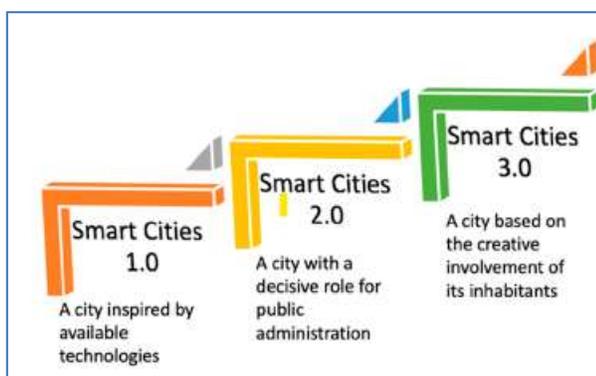
Source: (Korneluk et al., 2019)

Smart City 1.0 is characterized by encouragement of technology developers to adapt their solutions by cities. However, cities are often unprepared to use these technologies

and to properly assess how they can affect the quality of life of their inhabitants. It should also be emphasized that Smart Cities version 1.0 misses the key aspect, which is the interaction of cities with their citizens.

In Smart Cities 2.0 the dominant role is played by city authorities, which focus on modern technologies as tools enabling the improvement of the quality of life of the inhabitants. Cities included in the second generation of smart cities are characterized by a large number of urban programs and projects that implement modern technologies in various areas of city life.

Smart Cities 3.0 is the latest generation of smart cities. It is characterized by the fact that inhabitants play a key role in the development of their cities. But it is much more than the standard procedure of the participatory budget in Poland, which puts the decision on only a fraction of the city's budget into the hands of the inhabitants. In third generation of smart cities, residents begin to co-create their cities. Examples of this type of city are: Vienna, Vancouver, and Medelin (Colombia), which shows that cities of this type do not have to be located in highly developed countries. Importantly, social projects play a significant role in Smart Cities 3.0 (Korneluk et al., 2019).

III. EXAMPLES OF IMPLEMENTATION

Since 2017, the "Smart City Index" ranking is being developed by the IMD Business School in Lausanne, Switzerland together with the Singapore University of Technology and Design. Cities are rated on a scale from A (best score) to D, and the breakdown includes two main categories: infrastructure and technology, broken down into health and safety, transport, work and study, and city governance. The ranking is based primarily on the opinions and insights of residents, but experts are also analyzing how technology improves citizens' lives.

Ranking leaders in 2021 include (Rankingroyals; 2021):

1. Singapore
2. Zürich (Switzerland)
3. Oslo (Norway)
4. Taipei City (Taiwan)
5. Lausanne (Switzerland)
6. Helsinki (Finland)
7. Copenhagen (Denmark)
8. Geneva (Switzerland)
9. Auckland (New Zealand)
10. Bilbao (Spain)

In 2021, both Warsaw and Krakow received a "C" rating in all categories, taking respectively 75th and 80th place out of 118 assessed cities. In 2020 it was a "B" rating, which constituted a significant decrease compared to previous years. Residents gave a low rating of, among others: traffic flow, access to housing and air quality. In terms of technology and smart city solutions, online solutions for planning of communication, Internet speed and easy access to online job

offers were rated highly. On the other hand, applications facilitating parking, public transport and the use of carsharing fared poorly (CEO, 2022).

An interesting example of innovative solutions in the creation of a smart city that has already achieved international fame is Amsterdam. It is a model case of adjusting the "smart" concept in order to meet the needs and, more importantly, the possibilities of the residents. IJburg, the newest district of Amsterdam, which construction began in the late 1990s, was designed with young families in mind. Mainly young, ambitious people settled there. They live in modern houses with access to high-speed Internet. All this creates a perfect set of circumstances for testing new products and services in the district. Residents, together with the city and companies, organized a pleasantly arranged and furnished space equipped with, for example, new audiovisual technologies.

Another district: Nieuw West, was also included in the experiment. Contrary to IJburg, it is the older part of the city, characterized by, inter alia, high consumption of electric and thermal energy which is inhabited by "traditional Amsterdammers". In recent years, the district has been equipped with the smart energy grid, which is the newest in the whole Netherlands. The project was carried out as a cooperation between the city of Amsterdam and company Liander, which belongs to the European vanguard in the field of intelligent energy solutions. The grid enables flexible selection of energy sources and accurate measurement of energy consumption. It also created an ideal experimental area for companies dealing, among others, with providing installations enabling the production of energy from renewable sources. Residents can therefore download a number of educational materials in the form of easy-to-understand graphics and even games created by energy companies to their computer. An example of another app is Mobypark, which allows owners of parking lots to rent them to residents for a fee. The data obtained from this application can then be used by the city to determine demand for parking spaces and the intensity of traffic in Amsterdam. Many houses have also been fitted with smart energy meters, with incentives provided for those that actively reduce energy consumption (Komninos, 2013, p. 77; Amsterdam Smart City...). Another initiative concerns flexible street lighting. Smart lighting (Flexible street lighting, 2016) allows city officials to control the brightness of street lights.

IV. OBSTACLES AND DANGERS OF IMPLEMENTING SMART CITY

The growing popularity of the "smart city" concept is reflected in the actions of the authorities of the cities. However, many cities still cannot implement such investments. This is the case not only for financial reasons. Research has shown that as much as 68 percent of cities lack technological knowledge to build digital platforms. Also, the technological awareness of city officials is not sufficient enough to initiate and implement modern solutions.

Data issues are a big challenge. Collecting rich and complete data together with advanced analytics can allow cities to utilize potential of new technologies, but it raises major social concerns about privacy (63%). 43 percent of city officials also point the huge gaps in IT infrastructure in data management by the city and 39 percent point out lack of funds for such investments (Capemini, 2020).

The obstacles in implementing smart city in Poland include (Czupik et all., 2016, pp 223-235):

- difficult financial situation caused mainly by investment activity in recent years; as a consequence, new projects which require the highest capital, i.e. transport, energy and waste management, must be reduced or postponed;
- Terms of office of the city authorities, which may adversely affect the continuation of the strategy chosen by the predecessors under new administration; political risk is a barrier that is difficult to overcome; it requires building an alliance beyond divisions, party affiliation and personal antagonisms;
- lack of awareness of recipients about rational use of utilities; the task of local authorities should be to build the attitude of a conscious consumer who uses energy, gas and water during periods that guarantee lower bills and no risk of overloading the grid;
- • resistance to change; it is a natural reaction of society; hence, the introduction of new urban solutions should be preceded by extensive information campaigns and consultations.

Some risks associated with the implementation of the smart city concept may also occur. According to Hollands (2008), too much focus on the idea of a smart city, especially in the technological dimension, may have a negative impact on the development of modern network infrastructure, as well as result in ignoring alternative ways of city development. Patterns of development which are not based on the business model should also be seriously taken into consideration. An inherent feature of such a model is the mobility of capital, meaning that the capital may flow in as quickly as it may depart from the city, especially when another location offers more benefits and therefore more profit can be earned there.

Another threat to the city's development is the social exclusion of certain groups, which may deprive them from the possibility of using services offered by a smart city - e.g., low-income, elderly, disabled, with addictions, etc. For example, the above-mentioned groups use their mobile phones much less frequently than the rest of the city's community. Therefore, if the data sent by these devices is registered and processed, and certain public services are provided on this basis, it may turn out that they will not be adjusted to the structure of the city's community. In addition, the implementation of revitalization projects with an aim of changing the urban space may result in gentrification of the area, i.e., a sudden change of the character of a given part of the city resulting from the implementation of investments which nature is different than its immediate

surroundings. The result may be the creation of an enclave that will have no connection with areas surrounding it.

V.   IMPLEMENTATION OF THE SMART CITY CONCEPT ON THE EXAMPLE OF BIELSKO-BIAŁA

Bielsko-Biała - a city in southern Poland, in the Silesian Voivodeship, at the foot of the Beskidy Mountains, on the Biała River, at an altitude of about 310 m above sea level. Currently, it is the capital of the powiat (county) and is inhabited by nearly 170,000 residents. It was created from the merger of two towns: Bielsko and Biała. It is a picturesque tourist and cultural destination. Places worth seeing in Bielsko-Biała include, among others: Market Square, Sułkowski's Castle, Town Hall, Weaver's House, and many others.

Smart city in Bielsko-Biała is an investment in the development of the city, which includes:
- ZgłoszeniaBB" system,
- Residents Notification System (SPM),
- BBnet - a network of city hotspots.
- ITS - Sustainable Public Transport in Bielsko-Biała.

„ZgłoszeniaBB" system - was launched on February 1, 2018 and it allows residents to submit comments, problems and malfunctions in the urban space according to strictly defined categories, including:
  • reporting damaged bus stops, barriers, posts, road signs, road surfaces,
  • reporting fallen boughs, broken trees, and the need to cut down trees located in public spaces;
  • malfunctions/changes to traffic lights and street lighting;
  • dead animals and rodents in a public spaces;
  • illegal dumps, littered sidewalks, overfilled rubbish bins.

Along with the report, residents can indicate the location of the incident and attach photos.

Registered reports are forwarded for implementation and published on a public map which also shows the status of implementation, and most importantly - residents registered in the system have the possibility of viewing the status of their reports and receive up-to-date information on how they will be implemented.

In addition, the system allows publishing important messages and notifications from the commune, directly on the map, such as, weather warnings, sports and cultural events.

The system is available on the website www.zgloszeniabb.pl or through the free mobile application ZgłoszeniaBB, available for download on devices with Android and IOS.

City of Bielsko-Biała received the prestigious "Innowacyjny Samorząd 2020" ("Innovative Self-Government 2020") award for the implementation of the "ZgłoszeniaBB" system and application.

On February 1, 2019, the "Zapytaj Prezydenta" ("Ask the Mayor") service was launched as part of the "ZgłoszeniaBB" system. Each resident, after logging in to the system, can easily question the Mayor of the city on matters important to him personally or to the city.

Residents Notification System (SPM)- sends official notifications to a specific resident regarding, for example, the expiry date of the permit, the date of the upcoming payment, late tax installments payments, etc., and information about various events taking place in the city.

Due to legal requirements, in order to receive notifications, the resident must submit a request (in paper or electronically) to receive SMS or e-mail notifications.

BBnet hotspots- is a network of city hotspots enabling residents to connect to the Internet free of charge in public places in the city of Bielsko-Biała. Outdoor hotspots are located in the city center and in recreational areas (18), while indoor hotspots are located in the buildings of the Bielsko-Biała City Hall (5). In order to use hotspots, the user must accept the Terms and Conditions after connecting to the appropriate network (SSID: "BBnet_2G" or "BBnet_5G").

ITS - Sustainable Public Transport in Bielsko-Biała - As part of the project carried out in two phases: in 2017-2018 and 2020-2021, the following activities were carried out (Sprint, 2022), (Fig. 2):

FIG. 2. ELEMENTS OF ITS BB SYSTEM
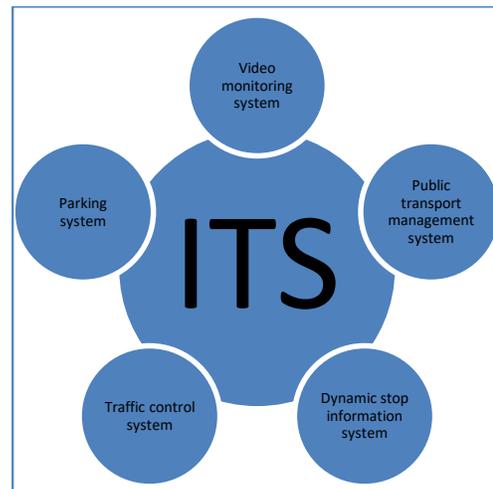
Source: Own study based

Video monitoring system - consists of network IP cameras with Full HD resolution and analog video-detection cameras. The video monitoring system has been integrated with the existing system functioning in the Municipal Guard. The preview from the cameras was also made available to the Municipal Police Station in Bielsko-Biała.

Public transport management system- it ensures supervision and management of public transport vehicles, provides tools for planning, designing and managing timetables, vehicle fleet management, and enables the implementation of priorities for public transport vehicles. As part of the project, the vehicles of

the carrier's fleet were equipped with on-board computers compatible with the ITS system, as well as internal LCD monitors for presenting passenger information. Variable message signs (VMS) have been installed to inform drivers about traffic disruptions. Video surveillance cameras were also installed at 18 intersections and 15 bus stop information displays (two cameras on each). In addition, several dozen cameras were located at the main entrance roads to the city, in the "Hulanka" tunnel and three underground passages. Such an extensive IT system not only enables more efficient communication and traffic management, but also allows for an immediate reaction to emerging dangerous road situations. Cameras and sensors located at entrances to the city provide data by reading vehicle license plates. This data can be used to monitor the volume of transit traffic through the city with the traffic load on individual arteries.

Dynamic stop information system - passenger information displays have been installed at the bus stops (7-line double-sided LED boards with a resolution of 104,192 pixels). These boards show the actual arrival time of buses, and additionally they have been equipped with devices which read aloud information about bus arrivals by speech synthesizer for the visually impaired (short mentions).

Traffic control system – it improves road traffic conditions in the city, with particular emphasis on public transport. Thanks to the mechanism of prioritizing public transport vehicles, it is possible for public transport vehicles that are delayed in relation to the timetable to smoothly cross intersections with traffic lights. Thanks to the possibility of continuous monitoring of the position of vehicles, there is a faster response to possible traffic difficulties, i.e. detours and traffic congestion.

Parking system – information displays which lead to municipal parking lots have been installed. Devices with electronic displays are located at the main entrances to the city centre of Bielsko-Biała. Displays inform drivers about the number of free parking spaces in six municipal parking lots, and arrows indicate the direction in which the parking lot is located. The parking lots are equipped with sensors measuring the number of vacant spaces. Thanks to the implementation of the task "Expansion of the Intelligent Transport System in Bielsko-Biała", new methods of measuring the occupancy of parking lots were used, and an innovative mechanism for obtaining data on a national scale was implemented.

CONCLUSIONS AND PERSPECTIVES FOR FURTHER RESEARCH

The innovative technologies used so far in Polish cities are usually not comprehensive in character. These are individual improvements that do not significantly affect the quality of life of residents, the natural environment and the reduction of public spending. Therefore, it seems that local government authorities should be oriented at comprehensive system solutions in the field of communication, energy, waste management and social

services. Energy savings, more efficient traffic, greater public safety and a healthier environment are just a few of the many benefits that smart city solutions offer.

Bielsko-Biała is an example of a city that can be included in the second generation of smart cities (Smart Cities 2.0): a superior role is played by city authorities that use modern technologies as tools to improve the quality of life of residents. The city is characterized by a large number of municipal programs and projects that implement modern technologies in various areas of city life. The most comprehensive system implemented in Bielsko-Biała is the Intelligent Transport System, which implements an innovative mechanism for obtaining data directly from Google servers. Thanks to this cooperation, variable message signs show the travel times to specific points in the city and measure the volume of traffic, without the need to install additional sensors and software increasing the costs of the entire system.

The aim of this study was to present the concept of Smart City as the direction of city development in a sustainable manner. The years 2021-2023 - a difficult period: pandemics, war in Ukraine, energy crisis are the events that made city management huge challenge for local governments due to growing financial, energy and environmental problems. In such a situation, investments in new technologies are not a priority, despite the fact that the use of IT solutions would contribute to reducing the costs related to the functioning of the city.

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