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FACTORS CONDITIONING THE IMPLEMENTATION OF THE SMART CITY CONCEPT

DETERMINANTY WARUNKUJĄCE IMPLEMENTACJĘ KONCEPCJI SMART CITY

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Abstract: Due to the scale of urban development as well as the level of urbanization of society, increasing problems are being identified in achieving the effective management of urban space. Problems of the communication system, media management and the efficient implementation of administrative processes are the main reasons for the search for technological solutions that would automate the operational processes of city management. The aim of the article was to identify and indicate the main areas of the functioning of cities that undergo technological transformation in order to improve the service of processes. The research methods used in the article were the analyses of literature and of the smart urban solutions used in Polish cities. The development and functioning of cities have a huge impact on the natural environment and general living conditions of the inhabitants. Due to the problems arising from urbanization, innovations are tested in cities to solve them. An example of this is the concept of smart city and the related technologies. Firstly, it is worth looking at the process of urbanization and the conditions for the development of urban areas. cities such as Wrocław, Poznań, Gdańsk and Łódź.

Keywords: smart city, e-administration, urbanization, smart networks, Internet of Things.

Streszczenie: Ze względu na skalę rozwoju miast, jak również wzrost poziomu urbanizacji społeczeństwa identyfikuje się coraz większe problemy z osiągnięciem skutecznego zarządzania przestrzenią miejską. Problemy systemu komunikacji, zarządzania mediami czy sprawne realizowanie procesów administracyjnych to główne przyczyny poszukiwania rozwiązań technologicznych, które zautomatyzowałyby procesy operacyjne zarządzania miastami. Celem artykułu jest zidentyfikowanie oraz wskazanie głównych obszarów funkcjonowania miast, które przechodzą transformację technologiczną w celu usprawnienia obsługi procesów. Metodami badawczymi zastosowanymi w artykule była analiza literatury oraz analiza stosowanych inteligentnych rozwiązań miejskich w polskich miastach, takich jak Wrocław, Poznań, Gdańsk czy Łódź.

Słowa kluczowe: inteligentne miasto, e-administracja, urbanizacja, inteligentne sieci, Internet rzeczy.

1. Introduction

The use of information and communication technologies determines the development of all areas of life. Urban space is one of such areas where a significant increase in intelligent solutions can be observed.

Urbanization is a natural element of social development, while the effective management of urban space becomes more and more difficult without the use of technological solutions. These solutions are designed to support the implementation of processes such as transport, media management and communication with residents.

Despite the fact that the smart city concept has been functioning both in literature and in practice for over a dozen years, the problems related to the creation of intelligent solutions supporting urban space are still relevant and extremely important for the further sustainable development of cities.

Identifying problems in the process of sustainable urban development determines the search for solutions that will allow for further development, and will also have a significant impact on the improvement of city management processes.

The aim of the article was to indicate the main areas that are undergoing transformation towards the smart city concept, as well as to indicate the scope of the benefits but also the risks associated with the technologization of urban space and the processes of city management.

2. Problems of modern cities

Over the past few decades the world's population has grown significantly, and with it, quality of life expectations. More than half live in urban centers. In all the countries, urbanization processes are taking place under the influence of globalization and technological progress. The United Nations estimates that 66% of people will live in cities by 2050. Cities should best meet social needs and be conducive to running a business. However, these requirements are constantly changing. The grow-

ing population is associated with the increased demand for utilities (cities use 60-80% of global energy resources) and the increase in waste and pollution (Pichlak, 2018, p. 192).

The development and functioning of cities have a huge impact on the natural environment and the general living conditions of the inhabitants. Due to the problems arising from urbanization, innovations are tested in cities to solve them. An example of this is the concept of smart city and the related technologies (Czupich, Kola-Bezka, and Ignasiak-Szulc, 2016, p. 224).

The growth rate of cities definitely exceeds the growth rate of the total population, which is referred to as a demographic explosion. In the period 1950-2014, the world's population increased almost threefold, while the urban population grew more than fivefold during that time (Gołata and Kuroпка, 2015, pp. 162-165).

Currently, the most urbanized regions of the world are North America (82% of citizens live in urban areas), Latin America and the Caribbean (80%), followed by Europe (73%). The greatest increase in the urban population over the next decades is forecast for Africa and Asia (Szymańska and Korolko 2015, pp. 11-12). According to estimates, this year in the EU the percentage of people living in cities will amount to 80%. In Poland, this value is currently over 60% (Pichlak, 2018, p. 192; Gwiazda, 2015, p. 373).

Urbanization takes place on all continents and it is a social phenomenon typical of our age. Generally, it is defined as "the process of concentration of the population in certain points of geographical space, mainly in urban areas" (Stawasz and Sikora-Fernandez, 2015, p. 13). In a broader sense, urbanization is defined as a multi-dimensional system of economic, social, demographic and cultural processes (Dyk, 2015, pp. 123-126; Węclawowicz, 2003, p. 62).

Metropolization is a concept related to urbanization, which is characterized by a new way of territorial division of capital, labour and knowledge. It consists in creating a new type of spatial structure with a competitive advantage in the international dimension. The area undergoes strong expansion, the phenomenon of exports appears and creates patterns of behaviour that are transferred to other areas (Stawasz and Sikora-Fernandez, 2015, pp. 15-16; Szymańska and Korolko, 2015, pp. 13-14; Albino, Berardi, and Dangelico, 2015).

Urbanization takes very different forms depending on the region of the world. Urban conditions, which are considered to be standard in some countries, can be seen as a serious problem in others. This contrast is especially marked when comparing developing countries with more developed countries (Wójtowicz, 2018, p. 28).

For this reason, it is difficult to select measurement tools as issues such as population density, traffic density, transport conditions, noise levels, air and environmental pollution are relative (Turała, 2015, pp. 53-55).

This is due not only to the economic situation, history and the natural environment, but also to traditions and socio-cultural values. What conditions are considered

tolerable and which are seen as unacceptable can also evolve, depending on economic development and cultural changes (Malikowski, 2015, pp. 7-8).

However, continual expansion has some consequences, and cities face a number of problems. Unfavourable factors or the non-application of optimal solutions lead to additional costs incurred by users (expenditure from the city budget and costs of economic entities as well as farms). The following areas are most often indicated in literature and in urban development strategies (Gitling 2015, p. 145; Internet 1-Internet 12):

- security,
- energy,
- spatial planning,
- transport and public transport,
- administration,
- waste management,
- environmental protection.

The effectiveness of administration depends on many factors, including those from managerial behaviour, entrepreneurship and creativity of the authorities, the available financial resources (budget), the qualifications and experience of public institutions and their cooperation, and the coordination of activities. Management is difficult in spatially expanding cities. Urban areas often include several cities, which requires the cooperation of authorities. The problems include conflicts of a various nature and the growing costs of the city's functioning combined with the simultaneously growing expectations of residents regarding their quality of life (Błaszczuk, 2015, pp. 34-35; Stawasz, 2015, p. 34; Jankowska, 2015).

3. Challenges for the smart city concept

The challenges that smart cities face are varied and complex. They depend on factors such as: government policy, the natural environment, the economy and local community. The main challenge facing a smart city is to meet the needs of its users whilst minimizing the consumption of all resources (per capita), and thus the impact on the environment (Mohanty, Choppali, and Kougianos, 2016, p. 11). The most important issues faced by city authorities include:

- privacy, security and trust,
- improving energy efficiency and reducing greenhouse gas emissions,
- reduction of unnecessary private transport,
- ensuring access to freshwater resources and reducing its consumption,
- optimal waste management and disposal,
- efficient water and sewage management.

In most cases the key task is to improve the substance and the processes of today's cities. Investing in modern technologies does not guarantee the sustainable development and success of a smart city (Chomiak-Orsa and Szurant, 2015b, p. 43).

It is very important to improve the existing structures, for example by encouraging environmental awareness and revising building laws that will contribute to higher energy efficiency in buildings. Frequently actions supporting the development of the city stem from the grassroots initiative of the local community, and they do not necessarily involve a costly investment.

Many devices are used in the smart city concept, such as smartphones, sensors and means of transport, process and store large amounts of data (Chomiak-Orsa and Szurant, 2015b, p. 41). Accordingly, there are many concerns about privacy, not only from the technical point of view, but also from the legal and communication perspective. The users expect complete security and privacy when operating their systems. The challenge is to separate the real user identity from the collected data as this requires the use of advanced technologies such as encryption, access control and intelligent data aggregation. Managing the identity and preferences of the user should also be integrated with the protection of privacy which is not a simple task.

In the area of e-administration, an obstacle to the development and implementation of new solutions is the lack of horizontal and vertical integration between individual municipal initiatives. The problem is also the low interest on the part of the state authorities. The main requirements for the proper implementation of technologies in this area are standardization and interoperability.

In terms of mobility, the challenge for manufacturers of means of transport is to design vehicles that maximize the capacity of transported passengers and goods. It is also important to provide precise location information (especially in real time). Therefore it is necessary to constantly develop and improve positioning techniques, both with the help of satellites and in a situation where the GPS signal is not available. The challenge is also the implementation of new solutions to optimize the transport system such as a fast lane for emergency services or a carpooling system (increasing the number of passengers in a car by matching people traveling on the same routes, e.g. to work) (Pinaki and Mahesh, 2015, pp. 26-27).

Smart energy networks (smart grids) are the backbone for all areas of smart city functioning. The main challenge in this regard is the constantly growing demand for energy. In order to pursue operational efficiency and energy savings, a combination of intelligent processes and technologies is essential. It is necessary to create an effective supervision and control strategy for energy networks and buildings. Sensor networks should be introduced to control the quality of electricity, increase efficiency and receive feedback. Other challenges in this area are: intelligent street lighting systems, the impact of electromagnetic noise on the environment, and authentication, security and certification (Farmanbar, Parham, Arild, and Rong, 2019, pp. 5-18; Curiale, 2014, pp. 14-17).

Due to the population ageing, it is estimated that by 2050 as many as half of the citizens of developed countries will suffer from chronic diseases. ICT play a large role in adapting hospitals and health care facilities to the needs of society. Advances

in medical technology, ICT, biomedical engineering, and micro and nano technologies are contributing to better healthcare solutions and trends. The major challenges are: social communication, access to public and private services, product distribution, interoperability and maintenance, product life cycle, early field trials, pricing strategy and decision support systems.

4. Benefits and threats

Both the benefits and threats related to the application of smart city solutions may occur in various areas of city functioning and affect various stakeholders. This is due to the great diversity of the cities themselves and of their approach to the implementation of the smart city concept, hence it is difficult to present a universal set of benefits and threats. Studies of existing urban areas indicate, however, that some phenomena have a high chance of occurrence (Czupich, Kola-Bezka, and Ignasiak-Szulc, 2015, p. 226).

Potential benefits include improving public services and adjusting them to the preferences of the residents. Another advantage is the possibility of accelerating and simplifying the course of dealing with issues in the local offices, which allows to building their favourable image. The proper use of ICT has a positive impact on the financial liquidity of municipal companies, for example it allows to monitor consumption of utilities consumption and the supervision of power, water and gas networks which leads to an increase in revenues. The implementation of intelligent metering systems may contribute to the reduction of the costs of providing public services – for example, a system that checks the filling of garbage cans will reduce the costs of the municipal waste collection service.

Smart city solutions also have an impact on savings in energy use, e.g. thanks to intelligent street lighting control, adjusting the light intensity of lamps to the time of day or weather conditions. A city that uses the smart city concept in practice builds the image of a modern and well-functioning city, which attracts new investors, residents and tourists.

Intelligent systems are very often used in the field of transport. All stakeholders benefit from them – residents, authorities, enterprises, and tourists alike. Thanks to ICT it is possible to improve the comfort of traveling and living in the city, as they contribute to increasing traffic flow and reducing travel time. Real-time monitoring and measurement of the use of buses and trams allows to optimize the operation of public transport. Intelligent solutions also indirectly increase road safety and reduce noise levels. In turn, initiatives for low and zero-emission means of transport have a positive impact on air quality and the reduction of pollution and CO₂.

The implementation of intelligent solutions in power grids also brings many benefits for the city. The use of the so-called smart grid optimizes electricity consumption, which reduces costs. Remote-reading systems and modern meters

enable users to monitor energy consumption in households or companies on an ongoing basis (Chomiak-Orsa and Szurant, 2015a, p. 31). Another advantage of this type of solution is the remote management of energy demand in buildings. Consumption control protects against excessive network load and contributes to saving reserve power in power plants. The precise location of network congestion and losses enables its improved management. Thus, it indirectly increases the quality, efficiency and security of energy supplies.

With the development of smart cities, the amount of data will grow intensively, and most likely they will become an attractive target for cybercriminal attacks. The authorities and institutions planning to implement new technologies must take into account the risk arising from vulnerabilities in devices and software that may be used in a cyber-attack. The consequences of such an event may turn out to be very severe and cause large-scale losses or difficulties (Rot, 2017, p. 42). The elements that increase the risk are the insufficient computing power of devices, unsecured interfaces and software errors. Data privacy and gaps in authorization and authentication systems also pose a problem (Kitchin and Dodge, 2016, p. 4).

The widespread use of the IoT solutions raises many threats: Denial of Service (DoS) attacks, attacking weak passwords and software vulnerabilities, and cross-site scripting attacks (code hidden in the content of a page that leads to unintended actions by users). One of the potential threats is taking control of the system (e.g. power supply) by unauthorized persons and demanding a ransom or performing certain actions. Another scenario would be to disrupt the city's functioning, reduce its defences or cause chaos for political and military purposes. If cybercriminals target smart meters, users risk changing their meter readout and sending the wrong value to the service provider. In addition, access to these devices can be used to determine when the household members are in the building. In the event of a system hack, the potential criminal group has information on hundreds of homes in the area.

Another type of threat resulting from an excessive focus on the concept of a smart city (especially in the sphere of technology) is the fact that the authorities ignore alternative opportunities for city development. This type of approach may also cause negative effects of the development of the network infrastructure. As for the increasing computerization of public services, there is a risk of excluding certain social groups. Older people, those in a worse financial situation, people affected by disability or addiction may not be able to use certain technologies. For example, these groups use mobile phones less often than other city residents, which may make it difficult for them to access services offered by a smart city. Initiatives aimed at revitalizing urban space may lead to the so-called gentrification. This phenomenon consists in changing the nature of a given part of the city, e.g. due to the implementation of investments of a nature different from the surrounding area. As a result, there is a risk of creating an enclave that does not connect with the surrounding area.

5. Conclusion

Along with advances in technology, cities are looking for new solutions that would help them cope with contemporary problems, such as an increasing population, environmental degradation, global warming, and an ageing society. However, it is not enough to implement the latest systems to make the city smart. All activities must result from a thorough needs analysis and be carefully planned. It is essential that the residents and their quality of life are at the centre of any change.

While analysing the challenges faced by modern cities, conclusions were drawn that the introduction of appropriate solutions would significantly improve their functioning. The main barriers to the implementation of new technologies are: insufficient investment in research and development, high cost of projects, lack of long-term planning and the coordination of activities of individual public institutions. For each city, 'intelligence' will have a different meaning. Economic and socio-cultural factors determine the standards and norms of living conditions adopted in a given region. The needs of populations in highly developed and developing countries will be different. It is difficult to clearly define the boundary between smart and ordinary cities. Solutions belonging to the smart city concept are used in urban centres around the world. The IoT technologies are used in many sectors of the economy and in various areas of a city's functioning.

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