COGNITIVE TECHNOLOGIES IN SMART CITY

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Purpose: The main purpose of the article is to draw attention to the subject of cognitive technologies application, with particular emphasis in smart city. An analysis of this guess is particularly important at the moment we have it right now, namely right more and more to do with artificial intelligence and its use for intelligent city management.

Design/methodology/approach: This article uses the method of analyzing the results of research on the cognitive technologies in smart city available in the subject literature and in Internet sources.

Findings: In the realities of today's economy, many cities and metropolises want to be places that are increasingly friendly to their residents, those who work in them, visitors, tourists, etc., in a sometimes difficult because volatile macroeconomic environment. In this reality, however, there are cities that have succeeded in terms of accessibility and friendliness for people using the services of a city or metropolis. They are distinguished by high development dynamics and high quality of services. They occupy a significant place in the national and even international market. In the consciousness of modern citizens (especially the younger generation), the need for constant innovation in agglomerations has become noticeable, so that living/functioning in them is simply easier through access to more modern services.

Research limitations/implications: The article refers to the results of research on the cognitive technologies in smart city, both in Europe and in the world, with emphasis on the place of Poland against their background. Research is conducted on a continuous basis, because the factors that directly affect the quality of life in a smart city can constantly change - evaluate.

Social implications: The research results shown are important from the point of view of society. They are also a hint and a hint for future situations that may happen that it is worth being prepared for any changes, which is of great importance from the point of view of quality of life in a smart city and city management.

Originality/value: The innovative article is based on an in-depth analysis of the factors contributing to the increase in the quality of life in a smart city and the improvement of city management. The obtained results of the analysis and the formulated conclusions may allow their implementation to improve the quality of life in a smart city in the future using modern cognitive technologies.

Keywords: smart city, cognitive technologies, management, quality of life.

Category of the paper: research paper.

1. Introduction

Awareness of innovating in agglomerations in order to make life in them easier through access to modern services with the help of the use of cognitive technologies often does not directly translate into practical and favorable solutions for all people, especially those for whom, until recently, pro-innovation activities were particularly difficult. This primarily refers to the elderly or those with various types of disabilities.

Therefore, it is extremely important to determine the level of knowledge of residents about the concept of Smart City itself, digital technologies, areas where innovations related to Smart City development can be implemented, elements that make up living conditions, tasks of smart city management, financing opportunities for individual Smart City projects (i.e. basic concepts). The information obtained can provide a compendium of knowledge and set directions in the discussion to be undertaken with the residents of a given city.

2. Smart city vs. digital/cognitive technologies

It is worth defining at the outset what the terms smart city and digital technologies are. Well, in the simplest terms, a smart city is a developed urban area that uses human and technological potential for sustainable and balanced economic development and high quality of life through improvement in a number of key areas (Bourgeais, 2015; Effenberger, 2011; Knecht, 2010; Kolman, 2004, 2007; Mennad, 2008; Mercer, 2022; Niesior, 2020; Skrzypek 2001; Wawak, 2007; Wal, 2003).

Digital technologies, on the other hand, are technologies that use digital technology and information systems. It is an activity of a technical, economic and organizational nature aimed at introducing digital devices and digital systems into various areas of the economy. For example: digitization of libraries is a technological process that uses digital technology to archive library resources. The effects of the introduction of digital technology also include, but are not limited to: digital signature, digital cinema, digital printing, electronic mail, digital television, digital photography. Areas where innovations related to smart city development can be implemented are:

- economy,
- governance,
- society,
- security,
- infrastructure and transportation,
- environment.

The amount of data that institutions/companies need to process is constantly growing. This drives the development of digital technologies. Their implementation often provides a competitive advantage. Therefore, many entrepreneurs, managers see their opportunities in the implementation of cognitive technologies, artificial intelligence and robotics. According to data from the consulting firm Deloitte, the rate of growth of companies' spending on the implementation of cognitive technologies will increase all the time. According to Deloitte experts, several factors are driving the development of cognitive technologies and robotics. These are first and foremost the growing volumes of data that companies need to process. On top of that, the growth of the Internet and cloud computing capabilities are making companies more and more present in the digital sphere. In addition, emerging machine learning algorithms allow robots to be used in new roles. Cognitive technologies offer a variety of solutions beyond traditional applications, such as process automation and cost reduction. Artificial intelligence can replace some human tasks and significantly support decision-making. Competitive advantage will be achieved by enhancing human capabilities, not just replacing or replicating them (Deloitte, 2018).

According to researchers from the Department of Organization and Management at the Silesian University of Technology, cognitive technologies are therefore an interdisciplinary field of science that deals with the development and application of algorithms, tools and systems based on theories from psychology, neuroscience, computer science and artificial intelligence. They can be used to model, interpret, and automate complex cognitive behaviors such as reasoning, language comprehension, image and sound recognition, decision making, and learning. Cognitive technologies, combined with specialized human knowledge, enable the development of tools and methods that provide the ability to automate processes and their use in various fields such as management, information technology, marketing, financial services, digital security, or effective training. Examples of cognitive technologies currently include various implementations of artificial intelligence (AI), including machine learning using neural networks, speech and image recognition, natural language processing, data analysis tools such as chatbots, risk assessment and recommendation systems. Cognitive technologies are currently the basis for solving a wide range of business and scientific problems and, importantly, have the potential to significantly impact our daily lives and work (Technologie kognitywne…).

3. Smart City Management

Cities face a number of challenges that will only intensify in the coming years due to demographic and economic changes. The UN predicts that the world's urban population will nearly double by 2050. As a result, natural resources will have to be used more rationally than before, and cities will be forced to compete on a global scale. As the city grows, so too will the

problems of pollution, logistics, energy management, disparities in the standard of living of its inhabitants and, as a result, crime. Maintaining a positive economic balance (the 700 largest cities, home to about 20% of the world's population, generate more than half of the world's GDP) poses greater challenges for city services and authorities to manage them efficiently, not only in the face of crisis, but also in day-to-day operations. In order to meet these challenges and to systematize the knowledge on efficient city management, institutions and research centers around the world are trying to formulate a definition of a "smart city" that identifies the core areas whose proper functioning affects the overall well-being of the city and its inhabitants. One such working definition (working because the concept is relatively new) is that a smart city is a city that seeks to solve public problems through the application of ICT (information and communication technology) based solutions as a result of partnership cooperation between stakeholders, service providers, at the city management level. The answer to these problems can be the effective use of ICT (including the Internet, mobile phones) to rationalize resources. This allows development based on innovation, cooperation and information, which is part of the idea of a smart city and, increasingly, a sustainable city. The use of ICT in the process of city management will greatly facilitate the lives of residents, allow them to make sustainable decisions, involve residents in the process of co-determination and co-management of the city, and thus contribute to raising living standards. In light of smart and innovative solutions for cities, the problem of proper management of their resources, both human and natural, is becoming increasingly important. Thanks to the ICT revolution, the ubiquity of the Internet, personal computers or smartphones, cities are gaining new tools to solve their problems. They provide opportunities for cooperation between different interest groups and better access to information.

Figure 1. *Determinants of Smart City Management.*

Source: Own study.

In addition, it should be noted that the determinants of funding opportunities for individual smart city projects are diverse. In the most general terms, they can be divided into factors belonging to the environment, and therefore independent, and internal factors, subject to the management process, forming the internal resources of a given city.

External factors (macro-environmental factors) include, first of all:

- trends in technological development at the global level and the possibility of adapting modern technologies in the country,
- the progress of regional (European) integration,
- the general level of economic development of the country,
- the degree of openness of the economy and investment opportunities,
- conditions of the social, economic and legal system,
- the principles and practice of economic policy, including, in particular, innovation policy,
- the situation on the market of industrial and consumer goods and services.

External environmental factors have a huge impact on the formation of innovation in cities, but the most important are internal factors (microenvironmental factors), which depend on the way individual cities are managed, on the ability to use the creative abilities of resources and the proper management of material resources and infrastructure using the favorable environment.

1. Factors conducive to smart city management related to managers:
   - Creativity.
   - Openness to innovation.
   - Willingness to be different.
   - Organizational skills.
   - Education in a specific field.
   - Knowledge of foreign languages.
   - Acquired professional skills.
   - Course of professional work.
   - Experience in managing a company.
   - Ability to organize work with people.
   - Material motivation, need for economic success.

2. Factors conducive to smart city management related to employees:
   - Ambitious, educated staff,
   - Sense of community of interest, identification with the city,
   - Positive evaluation of the leader,
   - An appropriate organization that motivates innovative activities,
   - General working and salary conditions.

3. Factors related to the immediate market environment:
   - Residents' expectations of innovation.
   - Cooperation with residents.
   - Innovation of neighboring cities.
   - Lack of market access restrictions.
   - Labor market situation.
4. Location factors:
   - Environmental constraints.
   - The need to interact with local authorities.
   - The possibility of contact with a university or R&D institutions.
   - The nature of the infrastructure.
5. Legal and financial conditions:
   - Tax law.
   - Conditions for obtaining and repaying loans.
   - Legal protection of intellectual property rights.
   - Others.
6. Other conditions.

4. Smart City and Social Issues

It is well known that the constant popularization of attitudes of conscious participation in the life of cities by their inhabitants, and all the efforts to carry out tasks in this regard, are associated with an increased demand for utilities (energy, water, gas), transport services and housing, as well as serious constraints on public space. As a result, cities seeking to promote smart development need highly efficient solutions that generate sustainable economic growth and social well-being, reflected in improved quality of life for their residents. What's more, as global climate warming and economic instability continue, cities must become places where the problems of the modern world are solved (Czupich, Ignasiak-Szulc, Kola-Bezka, 2016; Lehrer, 2010; Glaeser, 2011; Katz, Bradley, 2013).

The application of modern solutions, cognitive technologies, while addressing social issues such as welfare, cultural offerings or quality of life, among others, therefore requires the adoption of a holistic model of city management in all aspects, reconciling a bottom-up governance approach with a top-down one, allowing the involvement of a wide range of stakeholders (city users, such as residents, among others) in the process (Kuzior, A., Kuzior, P., 2020; Kuzior et al., 2023). Thus, the very idea of a smart city should be to create and exploit relationships and linkages between human and social capital and information and

communication technologies (ICT), and even cutting-edge solutions from the world of cognitive technologies, in order to generate sustainable economic growth of cities and improve the quality of life of their inhabitants (Kuzior, Sobotka, 2019).

As is well known, a smart city in social terms is a city that is characterized by, among other things, a competitive economy (smart economy), i.e. an economy that is highly efficient and technologically advanced through the use of modern ICT technologies; that develops new products and services for society and new business models; that promotes the establishment of local and global links and the international exchange of high-quality goods, services and knowledge; and well-managed social capital (smart people), which is possible under conditions of social diversity, tolerance, creativity and participation. Thus, values such as social differentiation, tolerance, creativity, social engagement, as well as openness to innovation and flexibility, understood as the ability to adapt quickly to external and internal conditions, should accompany the development of smart cities. In addition, smart cities usually base their strategies on the application of information and communication technologies (ICT) in order to improve the standard of living of their inhabitants and to increase their participation in important decisions.

In addition, a high quality of life (smart living) should mean safe and healthy living in a city that also offers rich cultural and residential opportunities, while providing ample access to ICT infrastructure to shape lifestyles, behaviors and consumption.

At the same time, it is worth mentioning the threats to smart city development that may arise in the social sphere. These include the phenomenon of exclusion of certain social groups from the possibility of using the services offered by the smart city - e.g. low-income people, the elderly, those excluded from society due to disability, addiction, etc. In this context, for example, the authors of the article "Factors and Barriers to the Implementation of the Smart City Concept in Poland" (Czynniki i bariery…) refer to the valid observation of A. Glasmeier A. and S. Christopherson, that "these groups use cell phones much less frequently than the rest of the city's community. Consequently, when the signal sent by these devices is recorded and processed, and certain public services are provided on this basis, they may not be in line with the city's community structure". Therefore, in line with the common vision of European cities of the future, the presence of all stakeholders must be taken into account, leading all residents to be active in an integrated manner in all dimensions of sustainable development (Postrzednik-Lotko, 2020). It is therefore important to use digitalization to improve the quality of public services in a way that allows all city residents to participate in society (Kuzior, Sobotka, 2021.

Thus, the realization of the objectives of the Smart City development in the social field, including the support of the specializations necessary for the development of local potentials to improve public participation, requires specific actions to organize the public space in a way that allows its optimal use. This implies the emergence of new needs, including the need to provide public spaces with Internet infrastructure. For example, the progressive informatization of social life (more and more people of different age groups are using new information

technologies that facilitate communication, but also allow online payments, etc.), or the search for all kinds of information on the Internet by increasingly broad social groups, indicate the need for further informatization of public services. The traditional model of administration, based on serving stakeholders through personal contact, should also be made possible through the use of ICT tools.

In addition, in the Smart City, measures should be taken to raise consumer awareness in the rational use of utilities, based on the principle of building the attitudes of a conscious consumer who uses energy, gas, water at times that guarantee lower bills and no threat of overloading the network. As is known, modern cognitive tools allow to collect data on the current state of the city's resources and problems and make them available in real time. The ability to continuously analyze data is important in the context of constantly shrinking resources and increasing costs of their acquisition. Up-to-date knowledge on this issue allows to change production and consumption, and consequently - to reduce the consumption of natural resources without worsening the standard of living of the inhabitants.

In addition, the Smart City should support activities aimed at encouraging the desired behavior of residents in the following areas: safety, development of civic activity in the broadest sense, increasing the quality of education of residents, creating a variety of cultural forms and activities of residents, activating sports and recreational activities of residents, and strengthening active social policy activities. This can be achieved by:

- Implementing preventive educational projects for residents with an ICT component.
- Developing civic activity and active civic attitudes (initiating and implementing civic education in the field of self-government with the use of modern technologies).
- Initiation of projects on digitalization of offers for active use of free time.
- Improvement of the quality of education of the population and improvement of the range of educational and extracurricular activities with special attention to the current needs of the labor market, special educational needs and development of the interests of particularly gifted students, planning of the educational path of children and youth and career counseling with the use of distance communication technologies.
- Taking initiatives related to education in the formula of distance and hybrid education, aimed at developing digital competence.
- Creation of various forms and cultural and artistic activities of residents with the use of modern technologies (enrichment of the cultural offer and strengthening of existing cultural events, as well as retrofitting of facilities for cultural activities with modern technologies).
- Activation of sports and recreational activities of residents (digitalization of sports and recreational offer and digital retrofitting of local sports and recreational facilities).
- Minimizing social problems by implementing projects to improve accessibility (including digital accessibility) of public facilities for people with disabilities.

- Minimizing the social exclusion of seniors by developing all activities that improve the quality of life of seniors (initiating and implementing educational activities on the use of ICT for seniors).
- Supporting the implementation of projects to improve the quality of medical services through digitalization improvements.

5. Conclusions for the future

In today's economic reality, many cities and metropolitan areas want to be an increasingly friendly place for their residents, workers, visitors, tourists, etc., in a sometimes difficult, because changing, macroeconomic environment. Cities that are successful in terms of accessibility and friendliness to the people who use their services must nevertheless function efficiently in this sometimes very complex reality. They must be characterized by high growth dynamics and high service quality. They occupy an important place in the national and even international market. In the consciousness of modern citizens (especially the younger generation), the need for constant innovation in agglomerations has become noticeable, so that living/working in them is simply easier through more modern access to all kinds of services. This awareness should be directly translated into practical or advantageous solutions, especially for those people for whom, for example, pro-innovation activities have been particularly difficult until recently. To sum up, any activity in the field of society should therefore be related to the challenges of counteracting stratification or social exclusion, any acts of vandalism, including those related to unemployment, challenges of supporting the rational use of water, promoting social inclusion and healthy lifestyles. In turn, the ability to clearly formulate these challenges in terms of their optimal solution is the starting point for realizing the idea of a so-called "smart city".

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