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COGNITIVE TECHNOLOGIES IN SMART CITY SERVICES AS THE FUTURE IN STRATEGIC MANAGEMENT OF CITIES

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Abstract:
The purpose of this paper is to indicate the possibility of applying cognitive technologies in smart city services and analyze their impact on strategic management in the city. The subject of this study is the use of cognitive technologies in big data as one of the tools of smart city. The study also identifies the risks that may occur when using modern technologies at the local level. At the same time, it refers to features that can provide a form of safeguards for an individual's rights and freedoms. This article also covers legal issues that affect the use of cognitive technologies in local government units. This paper indicates that the challenge that local governments should now meet is to build a Smart Sustainable City. Implementation of modern solutions should strive to improve the lives of all residents and thus prevent the exclusion of social groups or individuals.

Key words: *smart city, cognitiv technologies, new technologies, sustainable city development, big data*

INTRODUCTION

Due to the progressive digitalization processes in many areas of individual life, which have also been greatly accelerated by the COVID-19 epidemic, local community structures and their needs require changes. The drive of city managers towards smart development, the smart city concept, is no longer perceived as a modern vision of the future, but as a requirement that local government units should adapt to [1]. Sustainable city development will be even more strongly based on new technologies. The integration of economic, political, environmental, and social activities is already taking place using digital development. The adaptation of the services provided by local government units, whether in the field of administration, road transport, or waste collection, must aim to level up in relation to the technological changes occurring in the daily lives of residents. These goals can be achieved, among others, by using cognitive technologies in the design of smart city services.

A conscious leader managing the city takes into account both the current and future local problems while shaping the directions of city development. Therefore, while planning activities, the leader tries to prevent those problems or reduce their negative impact. The smart city concept is meant to help build the city of the future. Thus, when thinking about smart cities, one considers not only the way of managing the city or implementing environmentally friendly systems but also communication and information technologies. [2]. This applies to communication and information technology, whether it is the use of technology to support operations, technology to support the management of the operations of a virtual organization, or the possibility of visual interaction between a computer and a human. In combination with the rise of cognitive technologies, whose application allows the analysis of social connections and changes, the construction of the smart city will be based on sensing the future behaviour of the local government community and planning its safe development.

LITERATURE REVIEW

A great contribution to solving urban management problems using smart city concepts has been made by researchers. Currently, the application of cognitive technologies in smart city services has become an important topic in the scientific literature. These topics are relatively new, however, and requires further research. It is therefore worth noting how cognitive technologies are used in the management of Big Data and what impact this has on strategic management of the city. The literature on this subject does not provide answers to many questions, in particular how to combine modern technologies at work in

structures such as local governments, which are highly bureaucratic and strictly regulated by law. Moreover, it is necessary to analyze the benefits and risks that are associated with the use of cognitive technologies in building smart city and its impact on local community.

The starting point for cognitive technologies is traditional cognitive science, which is concerned with the observation and analysis of how the senses, brain, and mind work. These characteristics are used to develop the functionality of information technologies by modeling them on human cognitive processes [3]. Thus, in cognitive science, the basis is the human mind, which is treated as a cognitive system. The mind as a system allows us to receive information from outside, elaborating and using it at a further, necessary stage. Cognitive technologies use these dependencies to automate processes. In turn, their application in the development of the city of the future will improve its functioning, the attractiveness of the urban environment and the quality of life of its inhabitants. The aim of the smart city is to integrate urban, economic, infrastructural and social development [4].

While the use and prediction of cognitive technologies has been explored by the authors in the paper [5] and the benefits and utility of new technologies and their impact on management practice are considered by [6] it is still necessary to analyse the above issues in with reference to the specificity of Polish cities. The growing need to provide modern e-services has become a catalyst for the development of new technologies. However, research shows that currently still 67% of respondents prefer to visit the office in person [1]. Thus, the analysis of the application of new technologies in the city of the future must take into account not only the future social structure but also the current one and, consequently, it is necessary to find the answer to the question how to increase the use of solutions based on new technologies by the city inhabitants [7]. The literature also highlights the importance of new technologies in researched areas, such as epidemiological analysis [8]. There is no doubt, then, that these technologies make it easier to analyze data and draw conclusions that were not previously considered. In strategic management, the availability of resource of data is crucial, and it is important to look at what mechanisms should become more popular in local government units. The use and design of Big Data as a solution used in the smart city was discussed by [9] and [10]. However, this should be extended to analyze the aspect of data security and the impact of Big data on the issue of individual privacy. The benefits and utility of cognitive technology development considered in conjunction with an analysis of the key features of such a system are considered by [11]. The issue should therefore be considered in relation to its impact on the smart city, i.e. a city-shaping its development on new technologies. while influencing the improvement of the quality of life of all inhabitants, but without diminishing the opportunities of future generations [12]. The smart city concept does not contain a closed catalog of requirements. It does, however, define the direction of city development whose actions equipped with mechanisms based on cognitive science will fit into the vision of a modern area designed for high living standards of its inhabitants.

The literature nowadays assumes that digitalization is treated as an opportunity to automate and simplify procedures – which are often considered excessive – occurring in public administration, but it also emphasizes the value of saving time and money, or the possibility of using a modern, advanced tool to support management decisions [13]. However, these issues must be reflected in the law and take into account the protection of individual privacy.

Digital progress is to be useful to humans in their multidirectional development as individuals and used at the local level for the development of the city of the future. However, for changes towards the development of Smart City, properly prepared administration staff is needed [14].

METHODOLOGY OF RESEARCH

This article is based on publicly available domestic and foreign literature. The first step was to collect data on the smart city concept and the use of cognitive technologies, including using online tools to survey the scientific literature. The second part of the research focused on defining the threat level of the security issue when using new technologies. This analysis was based on Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation). This research was based on two criteria: the use of cognitive technologies in selected smart city services and the safety of the use of the aforementioned technologies in the subject area. Finally, the article evaluates the use of cognitive technologies in smart city services as the future of strategic city management.

RESULTS

Cognitive technologies in Big Data management as part of the smart city

The specificity of big data, its integration, processing from various sources is still a challenge for both businesses and public entities. There is no significant difference in the method of data management in terms of the type of organization. The multitude of data results from the number of parallel processes occurring in the organization and their complexity. Cities are facing both the amount of data and information they have and their ability to use it effectively. The transformation of this process, however, has a future with the use of cognitive technologies and fits into the concepts of the smart city. First of all, due to the constant variability of the data processed by bodies of local government units for their management, there is a need for mechanisms that will learn on their own and, consequently, allow the results of the produced data analysis to be used for the management of the city itself.

Big Data should be understood as a process consisting of four steps:

1) data collection;
2) aggregation and correlation of data;
3) analysis;
4) drawing conclusions, searching for trends allowing to obtain new knowledge or discovering new connections between possessed information [15].

Merging information from disparate datasets is leading to the development of advanced information systems that allow predicting trends and discovering facts based on information from large databases. Adding cognitive solutions allows to design new functionality. The aim is to make better use of the information that cities (authorities and subdivisions) already have. The use of these mechanisms can help reduce the cost of government operations. Analyses of large sets of data are already used in particular in traffic management systems in large cities, or in situations of increased migration flows in translation services. When applying cognitive technologies, large collections, which are stocked with a range of seemingly irrelevant and unrelated information, build on the knowledge already held and draw conclusions that are central to the research area. The use of cognitive technologies in managing Big Data within the information held by cities will additionally translate into tangible results: better data quality, better information acquisition and processing, and based on that information, better decisions can be made on the fly and automatically. For example, the proper construction of a goal-oriented database using artificial intelligence and cognitive technology could contribute to the automated preparation of a draft of the state of the municipality report required by statute for the previous year (a requirement under Article 28aa of the Act of 8 March 1990 on Municipal Self-Government (i.e. Journal of Laws of 2022, item 559)). The report specifically covers the implementation of policies, programs, and strategies, resolutions of the municipal council, and the civic budget. It contains data that are already in the possession of the authority but need to be collected and structured in a manner designed by the mayor.

In the management of large databases, the following risks are often present: unknown data quality, massiveness of processed data, automated decision making and consequently uncertainty about the veracity of the conclusions drawn. In terms of the quality of source data, the problem – despite the size of the database – may be the failure to meet the criterion of representativeness or to verify their reliability. Consequently, when datasets are merged, these anomalies may be multiplied. In addition, data often lacks context, which will also affect its quality [16].

However, cognitive technologies have an advantage over other solutions in that they can be flexible and adapt to different needs due to the fact that they coordinate their activities independently. Thus, in the management of Big Data, they will not only allow to organize them, but to use cognitive and decision-making functions, which ultimately may translate into a new dimension of strategic management in the city.

Invariably, when using the aforementioned mechanisms, one must always keep in mind the risk of discrimination against an individual. Cognitive technologies aim to make the system constantly learn and ultimately prevent such situations, but it must not be forgotten that this risk can occur. Automated decision-making is regulated in particular at the European level and includes, above all, an obligation to analyze possible irregularities in the design phase.

Thus, Big Data using cognitive technologies can be a tool that will accelerate the automatic preparation of reports both for the purposes of superior entities and information for citizens. At the same time, the construction of such a database, given the ability to process large amounts of information, can be a recommendation for strategic and operational decision-making by managers of the local government unit. On the other hand, in the field of Big Data, ethicists signal the existence of insufficient legal provisions that normalize the scope of their permissible use [17].

Strategic management using cognitive technologies

For several years, the literature has clearly indicated that digital transformation is moving toward the use of cognitive technologies to make major business decisions [18]. It is not about the classical understanding of artificial intelligence, which currently supports decision-making processes, but about technology using communication processes, deep learning mechanisms. Cognitive systems are designed to take independent actions and decisions and thus – at this stage – support strategic processes. Ultimately, strategic management at the level of urban policy with the use of cognitive technologies will be a fundamental element of Smart City. It will become the task of the algorithm to eliminate human errors, but above all to diagnose the needs and problems of the local community both in the short and long term. In this case, it is possible to call it a kind of machine consultation (consultation with a machine equipped with cognitive technologies). What is important, cognitive technologies do not aim at replacing the human factor; in fact, they rely on the cooperation of artificial intelligence with human intelligence. Actions at the level of urban strategies must have a human, humanistic sense [19].

When referring to strategic management, one should keep in mind that it is the local government that not only builds the smart city, but also takes care of its sustainable development [20]. Such a city also cares about intergenerational justice and seeks to minimize the effects of possible exclusions, e.g. digital [9].

DISCUSSION

Safety in the use of cognitive technologies in solutions dedicated to urban development

When designing solutions based on cognitive technologies, especially in the case of services that will operate on a large scale, such as those dedicated to smart city solutions, in addition to the opportunities they provide, one must also keep in mind the risks. One of such risks may be

digital security risks, which most often occur at the level of data and information processing, including with big data, Internet of Things (IoT) or, for example, with intelligent traffic management or advanced use of video surveillance [21].

First of all, three categories of such threats should be noted: cyberwarfare, cybercrime, and cyberterrorism [22]. They can also be divided from the point of view of systemic (e.g., cyberterrorism, information operations) or common (cybercrimes) threats [23, p. 587]. In practice, due to their system processing, ICT threats can manifest themselves, for example, in the unauthorized disclosure of large data sets, malware attacks or blocking of service availability. The danger in using structured databases with modern technology can manifest itself in three attributes: availability, integrity, and confidentiality.

Thus, the design and operation of these solutions must be based on risk analysis and adaptation of adequate safeguards (including physical, environmental, IT and organizational).

Therefore an important aspect in this regard is the protection of privacy, which, in addition to the examples mentioned above, is also at risk at the level of data quality contained in large data sets. In their case, there is often the so-called incremental effect (especially in integrated ICT systems used by public administrations), where the sum of possessed information may allow for identification of an individual even if the dataset was originally anonymized. The data protection provisions apply to personal data, i.e. data about an identified or identifiable person. Thus, if personal data has been anonymized (removal of feature(s) from a data set that allow for unambiguous identification; it serves to completely deprive the data set of features that allow for re-identification of a person) the aforementioned provisions shall not apply. Research shows that with Big Data, it is often technically impossible to apply permanent anonymization [24]. Thus, the risk analysis and Data Protection Impact Assessment (DPIA) required by the data protection laws (Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation)) must occur during the design phase of new solutions to ensure security, not only of the data but of the individual's privacy. Additionally, since it is not currently possible to perform completely irreversible anonymization of data, the undertaking of Big Data activities must be properly controlled and supervised both internally by the controller and externally by a supervisory authority. The form of citizen oversight realized, for example, through the right of access to data, is also not insignificant. As a rule, however, when implementing systems based on cognitive technologies, it is assumed that they are equipped with characteristic features, i.e. adaptability, interactivity, iterability, and contextuality. Thus, equipping the system with the abovementioned solutions will also be part of the introduced safeguards. The assumption that a system based on cognitive technology is adaptive means mimicking the ability of the human brain to learn and adapt to changing circumstances and requirements. Thus, the system acquires additional data from new sources or modifies itself by using the existing data with the newly created relationship description [25]. The key features of interactivity and iterability cannot be overlooked either. The ability of the user to define their needs while helping the system itself define the problem is an essential element of cognitive technologies here. They simulate the ability to actually understand the meaning of external phenomena [26]. Consequently, additionally equipping the system with the competence to refer to the context makes these features a kind of safeguard in the risk analysis performed.

Under European law, a Data Protection Impact Assessment (DPIA) must be carried out, particularly if a given type of data processing will be carried out using new technologies. The purpose of this action is to estimate to a large extent the source, nature, specificity and severity of the risk of violation of the rights or freedoms of individuals. Among the various types of data processing, the legal provision thus dictates that special attention be paid to processing operations carried out using new technologies. Although the term is not precise, as it is difficult to say which technology is still considered new and which is not, it can be interpreted as meaning that special attention should be paid to new technical solutions. This is because it is necessary to point out that such solutions often carry as yet unknown risks.

CONCLUSION

The role of cognitive technologies in smart city services is to bring about automation of administration using mechanisms of observation, continuous learning, and adaptation to changing reality. However, it is necessary to involve local communities in the use of implemented mechanisms based on cognitive technologies, which should involve education of residents in this area. After carrying out these activities, it is necessary to examine how the particular age and social structures relate to the introduced changes, but also to verify the source data, i.e. how much and of what quality the data will be collected by local governments and, consequently, what results they produce after processing. When building a Big Data management system, it is necessary to periodically study the behavior of data consumers as well as data producers.

The security of the services provided should be a key consideration when implementing new solutions. Rapidly developing cognitive technologies and artificial intelligence make freedom and responsibility take on a new dimension and new meaning. However, machine learning will only be possible if residents interact with the systems. Today, local governments already have huge data sets. However, humans are not able to extract patterns from them in a fast and real-time manner on their own, which, for example, define the preferences of citizens. Hence, cognitive technologies that have self-learning capabilities are essential. The management of the city is most effective if

it finds support in the trends defined on the basis of analyzed data.

Undoubtedly, the use of smart city tools, including cognitive technologies, translates into sustainable city development. The goal of the smart city concept is to improve the quality of life of residents, and cognitive technologies help to adapt to their changing needs.

The analysis showed that big data alone in a changing reality without additional management mechanisms is not a sufficient solution for a smart city. However, it can be considered a first step to be introduced into the smart city concept. Cognitive technologies are what will make it possible to achieve the strategic goals, which are primarily to improve the quality of life of residents with changes taliored to their needs. As a result of the research, it has been shown that new technologies in the strategic management of the city bring threats and opportunities, as shown in Table 1.

At the same time, it is necessary to strengthen the legislative processes, because the legislation must keep up with the changing reality of digital solutions. Thus, they currently run the risk of being overly integrated into an individual's private life. European legislation on the right to privacy shapes it as an overarching value. Data protection authorities currently restrict the use of new technologies when they directly involve an individual's data. Indeed, a large volume of data can only be processed based on the consent of the user. More research is needed to reconcile digital development without compromising individual privacy.

Undoubtedly, keeping up with the changes occurring in the area of business that remains crucial for the directions of the city's development will be an opportunity for the local government in the scope of using cognitive technologies. Disproportion in that scope may lead to negative influence on local economy or even on the level of public finances. A developing local government equipped with modern solutions may itself be an incentive to start a business in its area.

Table 1

SWOT analysis of the use of cognitive technologies in the management of the local government unit

Opportunities	**Threats**
• Adapting to business changes; • Quick response to problems; • Prevention of conflicts / local problems; • Peaceful development of the local community.	• Failure to adapt the law; • Excessive interference with an individual's privacy; • Huge amount of data.
Strength	**Weakness**
• Supporting economic development of the city; • Taking into account possible future problems of local communities; • Ultimately lower costs; • Huge amount of data.	• Significant costl • Lack of real-time data analysisl • Not using all the datal • A lot of digital waste, consequently no trends.

Due to the multitude of data and information that local authorities have and use to manage the city, but also because of the number of legal changes, new technologies and especially cognitive technologies can become key support mainly in strategic processes, but also in operational processes or even unitary. The use of data analysis processed using machine learning mechanisms to prevent conflicts, social problems will therefore be a benefit to local government units. Rapid processing of information strengthens the security of local government community development.

Having hundreds, thousands of terabytes of data is both a strength of Big Data and a threat. On the one hand, the more data, the larger the research sample and the possibility to extract information that will have real value for decision-making at the strategic level. On the other hand, such amount of data requires adequate resources and continuous development of these technologies. It should also be remembered that it will involve the inability to use all the data and the creation of digital waste.

It should not be forgotten that in the initial phase, the implementation of such solutions requires considerable financial resources, which, however, should eventually reduce the operating costs of offices.

Thus, strategic management should strive to build a Smart Sustainable City, i.e. a city that shapes its development on new technologies and does not forget that the goal is to build a better life for its citizens.

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