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VALUATION OF LITHUANIAN CITIES' SMARTNESS

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Abstract

Research purpose. To assess the level of smartness of Lithuanian cities. The article systematizes the theoretical background of a smart city and its criteria, develops the methodology for measuring the level of smart cities and assesses the level of smartness of Lithuanian cities.

Design/Methodology/Approach. Methods used for the study: systematization, comparison, generalization, multi-criteria methods (COPRAS, EDAS and TOPSIS). The criteria for the assessment of smartness of cities were distinguished from the analysed scientific literature. Multi-criteria methods are used to determine the smartest city in Lithuania since they allow you to rank alternatives according to various criteria that are rendered dimensionless.

Findings. A multi-criteria assessment of the level of smartness of Lithuanian cities has shown that the capital city is leading. However, different results were obtained using different multi-criteria assessment methods in ranking the remaining cities.

Originality/Value/Practical implications. Usually, the smartness is analysed for major cities of the world, and Lithuanian cities were not assessed to the knowledge of the authors. The selected criteria for the assessment of the smartness of the cities represent the most often used (foreign direct investment; emission of the pollutant; the number of international immigrants; the ratio of people registered as unemployed to the working-age population; the number of crimes; the number of specialists trained at universities; the number of universities; the number of bus routes; the number of road traffic accidents; the number of IT companies and forest cover). The results could help for policy creators to make decisions on increasing the intelligence of Lithuanian cities, which would help to develop the economy not only in the capital but also in other important cities of the country and raise the quality of life of the inhabitants of those cities.

Keywords: Smart City; Smart City Criteria; Smart City Development; COPRAS, EDAS and TOPSIS.

JEL codes: O18; C38; O31; O32.

Introduction

The concept and phenomenon of a smart city are relatively new but has been spreading rapidly in recent years. Cities are becoming more and more advanced, making it much easier to solve various problems related to traffic, pollution, poverty, and unemployment (Dameri, 2013). Smart cities are a movement that aims to innovate, create a better environment, and improve skills and abilities (Zapolskytė & Palevičius, 2018). Smart cities reflect creativity, technological capacity and the ability to combine diverse, unrelated elements, knowledge, and processes. With the rapid growth of smart technologies, smart cities are also evolving steadily, becoming more and more convenient. This trend encourages the development of various smart technological solutions in cities, which are then used to develop the environment of public service infrastructure. Smart cities provide a higher quality of life, which is why it is essential to develop, adapt and use smart systems in various social and economic activities of cities, and to develop higher-quality infrastructure (Batty, 2017). For a city to become smart, it needs a favourable infrastructure, a focus on integration, innovation, and cooperation. Creating and developing a smart city requires careful, responsible work and planning.

Smart cities offer many benefits to society in terms of life quality and sustainability. Smart cities as a phenomenon represent the transition from an isolated city system to full openness in an intellectual

environment. The main goal of smart cities is to create a better and more comfortable environment for residents and to promote learning and innovation in various social fields. It is important to note that smart cities are associated with an environment that allows the integration of various, not necessarily interconnected, capabilities, information systems, elements, systems, and knowledge. The essence and concept of smart cities is still a new and not fully explored phenomenon. Although the importance and benefits of smart cities for nature and society are widely discussed around the world, the problems of smart city development are not clearly identified. The problem of the research is how to assess the level of smartness of cities. The research object is Lithuanian smart cities. This research aims to investigate the level of smartness of Lithuanian cities and to determine the smartest Lithuanian city based on the smart city criteria that are selected from the analysed scientific literature. To achieve this aim, several objectives are set: to systematize the theoretical concepts of a smart city, to create an appropriate methodology for assessing the level of smart cities, and to assess the level of smartness of Lithuanian cities. The methods used for the research are scientific literature analysis and synthesis: systematization, comparison, generalisation; multi-criteria decision-making methods EDAS (Evaluation Based on Distance from Average Solution), TOPSIS (technique for order of preference by similarity to ideal solution), and COPRAS (complex proportional assessment).

A multi-criteria assessment of the level of smartness of Lithuanian cities has shown that the city of Vilnius is leading in this context. However, different results were obtained using different multi-criteria assessment methods in ranking the remaining cities (Kaunas, Klaipėda, Šiauliai, Panevėžys).

Literature Review

The concept of a smart city is not clearly defined in detail and is not always used consistently. In scientific literature, the concept of a smart city is equated with terms such as a smart, digital or electronic city. A digital city is one in which most functions of services and management are in electronic form. However, the presence of electronic space and automation is not enough to indicate a smart or intelligent city (Komninos, 2006). A smart (intelligent) city is characterised by the active participation of residents in the development, management, and improvement of services. Scientific literature emphasises that a smart city is closely linked to feedback, innovation and the development of social intelligence. The concept of a smart city is not limited to technology. Various definitions and meanings of a smart city are found in the literature (Table 1).

Table 1. Definitions of a smart city (Source: author's compilation)

Author	Definition
Hajduk (2016)	A global trend in city strategies to restore city quality. Innovations and smart technologies are used to address problems related to social and economic problems.
Arasteh et al. (2016)	A city that applies a smart system characterized by the interaction of infrastructure, capital, behaviour, and culture, which is achieved through their synergy.
Caragliu et al. (2011)	When smart solutions are identified that allow modern cities to thrive by improving quantitative and qualitative performance.
Santinha and Anselmo de Castro (2010)	It is the relationship between a city and its environment, which emphasizes the importance of the organizational capacity, creativity and technologies of governing institutions.
Odendaal (2003)	A city that takes advantage of information and communication technologies, the opportunities they offer, their progress and influence.
Hall et al. (2000)	A safe city of the future, which preserves an ecological environment and has an efficient infrastructure. Advanced, integrated materials are used, consisting of databases, monitoring and decision-making algorithms.

All authors unanimously agree that a smart city is associated with innovation and smart technologies. A smart city is also closely related to improving the quality of life, creativity, prospects, solving residents' problems, and environmental friendliness. The creation and development of a smart city are based on

artificial intelligence – a key feature of the 21st century society. A smart city is a social and economic space in which governance and self-regulatory processes take place. The idea of a smart city arises from the application of technology to solve problems in cities (Dameri, 2013). Smart cities emerge when many different specialists, political views, economies, and cultures merge into one. Lakamp (2017) identifies six key aspects of a smart city that characterize a smart city: smart governance, smart economy, smart mobility, smart citizens, smart environment, and smart lifestyle. The author states that the creation and development of a smart city require forecasting and planning, as this helps to define goals and objectives, model possible situations, and anticipate people's reactions and accessibility.

Thus, a smart city is based on transparency, diverse strategies and perspectives, resident participation in decision-making, creativity, flexibility, environmental protection, and conservation of natural resources, accessibility, innovation, security, technological, educational and cultural infrastructure, and productivity. A city like this requires not only smart technologies but also the improvement, maintenance, storage, and replacement of smart technologies (Patašienė & Patašius, 2014). Smart cities also reflect user interfaces, the adaptability of residents, improved design, resilient and advanced energy, security, and privacy. Smart cities not only improve living conditions, conserve resources, provide easier and more convenient access to the needed information, goods, and services, but also contribute to the development of an intelligent, knowledge-based society. Smart cities are characterized by functionality, speed, and convenience (Leonavičius & Žilys, 2009). Resident involvement, innovation, and the use of digital literacy facilitate the development processes of a smart city.

Scientific literature indicates that the creation, development and solutions of smart cities are focused on raising the quality level and transforming the living environment. The creation of a smart city, like all processes, has a certain cycle. First of all, infrastructure is created, data is collected and processed, decisions are made, and then finally, services are provided to residents (Šiupšinskas, 2014). The final products, services, and resident services are referred to in scientific literature as applications or software. The final product in creating a smart city comes when all the necessary steps before this have been completed: the infrastructure has been set up, the data has been collected and processed. The final product provides city residents with access to a variety of electronic spaces where they can obtain and use relevant information about public transport, car flows, health care, education, culture, commerce, and other processes (Ferrara, 2015).

The development of smart cities is a process that was determined by the progress of science, technology, and the economy, as well as the needs of residents (Juškevičius, 2013). Smart cities, their creation and development all around the world are of great importance. With rapid transformation of the world's cities into smart cities, the optimization of city life is increasingly being considered. Smart cities are not a vision of the future but rather a topical reality and one of the most important principles of a modern city. Such cities are created and developed by implementing non-standard ideas, using imagination, science, knowledge and skills, and applying the principles of sustainable development (Calas, 2019). The development of a smart city, as a process, incorporates a variety of technologies, people, goods, businesses, transport, communications, and energy. The development of smart cities is important in that the living environment becomes more innovative, comfortable, and humane (Guo & Qi, 2019). The main elements of the importance of smart city development are indicated in the scientific literature (Table 2).

Table 2. Features of a smart city (Source: author's compilation)

Features / Authors	Building smart community	Conservation of natural resources	Functionality	Improvement of life quality	Availability of information and services	Traffic management
Guo and Qi (2019)	+	+	+	+	+	+
Alsaig et al. (2019)			+		+	+

Basumatary and Anand (2018)		+	+	+	+	
Cerruela García et al. (2016)	+			+	+	
Zapolskytė and Palevičius (2018)		+		+	+	+

In summary, the development of smart cities is essential for the development of a knowledge-based society (an increased number of specialists with higher education, an increased number of educational institutions in cities and improved quality of education and knowledge), conserving natural resources (cities become 'greener', more focus is placed on forest conservation and protection), creating a comfortable, functional city (leading to an increase in the number of immigrants attracting additional cash flow and FDI), creating easier access to information (city streets, residential, and commercial buildings become a network flow, which is controlled by sensors. As a result, crime decreases and people become more responsible), decreasing traffic flows (people choose public transport, which is a more convenient and faster method of travel and results in the decline in road traffic accidents), creating a life that is of much higher quality, more humane, and more convenient. It is also important to mention that the creation and development of smart cities, in turn, encourage the creation of IT companies, as they are one of the main drivers of smart cities. Scientific literature also states that the ratio between the unemployed and the working-age population is declining with the development of smart cities. When creating and developing a smart/intelligent city, its functions must satisfy the needs of all members of society (Tomičić Pupek et al., 2019). Thus, smart cities and their development are extremely important because they represent the transition from isolation to full intellectual openness. Presented are four key aspects that must be considered when creating and developing a smart city (Gascó-Hernandez, 2018):

- adopting multi-level governance models, assigning responsibilities across different levels of institutions and governments,
- promoting an integrated city policy with a holistic and strategic approach,
- focusing on new information and communication technologies to provide citizens with easier access to social and cultural content,
- ensuring sustainable territorial development based on the efficient use of resources.

Although the development of smart cities, as a phenomenon, has positive characteristics, there are often problems with the development of smart cities. In scientific literature, the development of smart cities is identified as a complex process that needs to be managed by creating an effective model and system that overcomes and solves problems arising in the long run (Tiškus, 2007). While the development of smart cities is a social process that ensures and streamlines social, economic, political, technological, and cultural processes, many problems are also encountered that must be continuously anticipated, modelled, analysed, and addressed. In the context of smart city development, multifaceted, complex, and universal problems are encountered.

When developing a smart city, there are many challenges related to educating people and informing them about new platforms. Technical and systemic challenges are also common. The scale of smart city creation and development is infinitely large, but there are constantly more and more various problems, mistakes, and incompleteness of models. With the expansion of smart cities, there are often issues with security and privacy, slow processing of large amounts of data, systemic disruptions, insufficient technological knowledge, and resident resistance. Problems of smart city development fall into three main categories (Figure 1).

Social problems are related to the community and city residents, economic problems – to finances, and technological problems – to information systems. Security and privacy issues are also related to cyber-attacks, which can occur in the presence of data security vulnerabilities. Technological challenges

arising from the development of smart cities are related to information technology. No one can guarantee that systems, models, and automated mechanisms in the face of an unusual and unforeseen situation will make the right decisions and will not make the situation catastrophic. Development problems may also be related to a lack of finances and investments. Creating or developing a smart city requires large investments for training people, purchasing machinery and equipment, and testing.

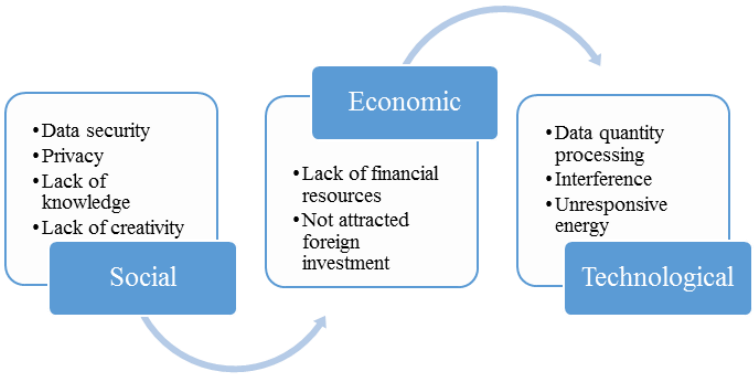

Fig. 1. Problems of smart city development (Source: author's compilation based on Gonzalez (2016))

In summary, the development of smart cities is caused by three groups of problems, which are related to resources, security, privacy, information technology, lack of creativity and knowledge. Thus, the problems of smart city development are multifaceted, often unpredictable, and universal. In order to anticipate such problems, it is necessary to model possible scenarios and analyse the data constantly. The problems of smart city development are complex in that they are new, unexplored, and unique).

Methodology

The current research has several stages. First, the criteria for the assessment of smartness of cities were distinguished from the literature. Second, the statistical data of the criteria were gathered. Third, multicriteria decision-making methods were employed in order to rank the largest Lithuanian cities in terms of cities' smartness. The research scheme is presented in Fig. 2.

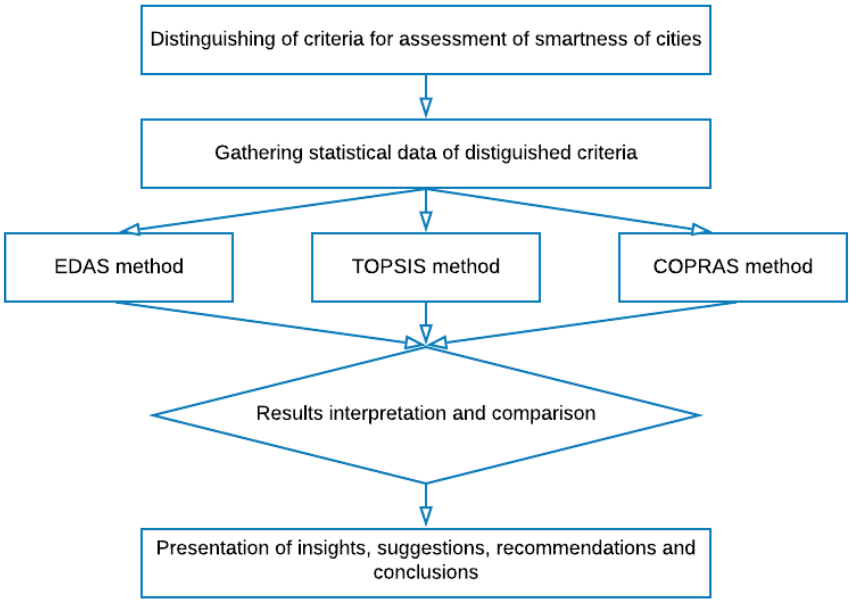

Fig. 2. Sequence of research to determine the level of city smartness (Source: author's compilation)

The criteria are based on scientific literature. According to the criteria of smart cities, five Lithuanian cities with all or some of the characteristics of smart cities are selected. After the multi-criteria assessment, all models are compared with each other in order to obtain the most accurate and reliable results possible, then the results are analysed. By applying multi-criteria assessment, the smartest Lithuanian city is determined using three different methods. Once the factors are identified, conclusions and recommendations are provided on what should be taken into account throughout the development of smart cities, which factors should be prioritized, and what requires the most focus, effort, work, and analysis.

The methods used for the research are EDAS, TOPSIS, and COPRAS. The advantage of multi-criteria methods is that they make values dimensionless. Some techniques are simple and easy to apply, while others are a bit more complex. Before performing the multi-criteria assessments, it is critical to determine whether the criterion is minimizing or maximizing and to determine the weight of each criterion.

The TOPSIS method is applied to both minimizing and maximizing indicators. This is the formula used to normalize the indicators. Positive ideal V^+ and negative ideal V^- solutions are calculated according to these formulas (Ginevičius & Podvezko, 2008):

$$V^+ = (v_1^+, v_2^+, \dots, v_n^+) = \left(\left(v_{ij} \,|j \in I \right), \left(v_{ij} \,|j \in J \right) \right), \quad (2)$$

$$V^- = (v_1^-, v_2^-, \dots, v_n^-) = \left(\left(v_{ij} \,|j \in I \right), \left(v_{ij} \,|j \in J \right) \right), \quad (3)$$

where: *I* is identified as the maximizing criterion and J as the minimizing criterion, i = 1, … , m; j = 1, … , n.

After calculating ideal positive and negative solutions, the distances to them are calculated according to these formulas (Ginevičius and Podvezko, 2008):

$$S_i^+ = \sqrt{\sum_{j=1}^n \left(v_{ij} - v_i^+ \right)^2}, \; i = 1, 2, \dots, m. \quad (4)$$

$$S_i^- = \sqrt{\sum_{j=1}^n \left(v_{ij} - v_i^- \right)^2}, \; i = 1, 2, \dots, m. \quad (5)$$

After determining S_i^+ and S_i^-, the relative closeness to the positive ideal solution P_i is calculated according to this formula (Ginevičius and Podvezko, 2008):

$$P_i = \frac{S_i^-}{S_i^- + S_i^+}, \quad (6)$$

All criteria are ranked according to the P_i values obtained. The best variant is the one with the highest P_i value and vice versa.

Another multi-criteria assessment method used in smart city development research is COPRAS. This method is quite commonly used and can be easily applied to a variety of quantitative studies. Normalization using the COPRAS method is performed according to this formula (Malinauskas and Kalibatas, 2005):

$$d_{ij} = \frac{x_{ij} q_i}{\sum_{j=1}^n x_{ij}}, i = 1, \dots, m; \; j = 1, \dots, n \quad (7)$$

where: x_{ij} – the value of criterion *i* using variant *j*; *m* – the number of criteria; *n* – the number of compared variants; q_i – the significance of the criterion.

The second step after normalization is calculating the sums of minimizing S_{-j} and maximizing S_{+j} estimated normalized indicators describing a certain variant, according to these formulas (Malinauskas & Kalibatas, 2005):

$$S_{+j} = \sum_{i=1}^m d_{+ij}, i = 1, \dots, m; \; j = 1, \dots, n \quad (8)$$

$$S_{-j} = \sum_{i=1}^m d_{-ij}, i = 1, \dots, m; \; j = 1, \dots, n \quad (9)$$

Next, the relative significance of the compared variants is determined based on the S_{+j} and S_{-j} values that describe them. Relative significance is denoted by Q_j and calculated according to this formula (Malinauskas and Kalibatas, 2005):

$$Q_j = S_{+j} + \frac{S_{-min}\sum_{j=1}^{n} S_{-j}}{S_{-j}\sum_{j=1}^{n}\frac{S_{-min}}{S_{-j}}}, j = 1, \dots, n \quad (10)$$

Based on the obtained values of relative significance, the ranking of the criteria is performed. The higher the Q_j value, the higher the rank number and vice versa.

The EDAS multi-criteria assessment method consists of six main steps. As with any multi-criteria assessment, the application of the EDAS method starts with the creation of a solution matrix. When the solution matrix is formed, the average of all criteria is calculated according to this formula (Ubartė, 2017):

$$AV_j = \sum_{i=1}^{n}\frac{r_{ij}}{n}, \quad (11)$$

where: r_{ij} – the value of the *i* alternative and the *j* efficiency indicator; *n* – the number of compared variants.

Once the average has been calculated, a calculation is made to determine the positive and negative distances from the average. Positive and negative distances from the average are calculated according to these formulas (Ubartė, 2017):

$$PDA_{ij} = \frac{\left(0,(r_{ij} - AV_j)\right)}{AV_j}, \text{when the criterion is beneficial} \quad (12)$$

$$PDA_{ij}\frac{\left(0,(AV_j - r_{ij})\right)}{AV_j}, \text{when the criterion is non} - \text{beneficial} \quad (13)$$

$$NDA_{ij}\frac{\left(0,(AV_j - r_{ij})\right)}{AV_j}, \text{when the criterion is beneficial} \quad (14)$$

$$NDA_{ij}\frac{\left(0,(r_{ij} - AV_j)\right)}{AV_j}, \text{when the criterion is non} - \text{beneficial} \quad (15)$$

Next, the sums of all alternative PDA_{ij} and NDA_{ij} significances are calculated according to these formulas (Ubartė, 2017

$$SP_i = \sum_{j=1}^{m} w_j\, PDA_{ij}, \quad (16)$$

$$SN_i = \sum_{j=1}^{m} w_j\, NDA_{ij}, \quad (17)$$

where: w_j – the significance of indicator j.

The next step is to normalize the SP_i and SN_i values. This is done according to these formulas (Ubartė, 2017):

$$NSP_i = \frac{SP_i}{max_i SP_i}, \quad (18)$$

$$NSN_i = 1 - \frac{SN_i}{max_i SN_i}, \quad (19)$$

The final step is ranking. The ranking of alternatives is performed by calculating the appraisal score according to this formula (Ubartė, 2017):

$$AS_i = \frac{1}{2}(NSP_i + NSN_i) \quad (20)$$

It is important to apply quantitative research methods to determine the level of smartness of cities. Multi-criteria assessment methods, which can be used to rank alternatives according to certain criteria, are ideal for this. Multi-criteria assessment methods are applied to assess the level of smartness of cities as the criteria are converted into dimensionless values.

Results

In order to assess the smartness and development opportunities of Lithuania's five largest cities, the criteria that describe the characteristics of smart cities and are essential in assessing development were selected as follows:

- foreign direct investment (mill. Eur),
- emission of pollutant (tons),
- number of international immigrants (units),
- ratio of people registered as unemployed to the working-age population (per cent),
- number of crimes (units),
- number of specialists trained at universities (units),
- number of universities (units),
- number of bus routes (units),
- number of road traffic accidents (units),
- number of IT companies and forest cover (per cent).

2018 data is analysed (Table 4).

Table 4. The initial data are intended to assess the level of smartness of Lithuanian cities, 2018 (Source: author's compilation, based on the Department of Statistics (2019))

Feature of a smart city	Functionality		Improving the quality of life/accessibility to information			Building a smart community			Traffic flow management		Conservation of natural resources
Criteria for measuring city smartness	FDI | Mill. Euro	Number of international immigrants | units	Emission of pollutant | tons	Ratio of people registered as unemployed to the working-age population | per cent	Number of crimes | units	Number of specialists trained at universities | units	Number of universities | units	Number of IT companies | units	Number of bus routes | units	Number of road traffic accidents | units	Forest cover | per cent
Vilnius	9958.73	5799	6899.86	6.10	14396	10239	12	3947	317	624	34.60
Kaunas	1214.68	2406	5370.53	7.20	8490	6466	4	1158	317	399	17.60
Klaipėda	911.55	1438	3378.37	6.40	4422	1127	2	321	79	168	19.90
Šiauliai	139.12	1319	988.63	5.30	2160	808	1	224	57	137	6.00
Panevėžys	259,44	510	1696,85	7,00	1910	0	0	149	474	167	1,60

Vilnius, compared to other cities, is in the lead according to nine out of eleven criteria. The lowest indicators prevail in Šiauliai and Panevėžys. After analysing the initial data for determining the level of smartness of Lithuanian cities, the results obtained after the multi-criteria assessment using EDAS, TOPSIS and COPRAS methods are presented (Table 5).

Table 5. The initial data are intended to assess the level of smartness of Lithuanian cities, 2018 (Source: author's compilation, based on the Department of Statistics (2019))

EDAS			TOPSIS			COPRAS		
	AS_i	Rank		P_i	Rank		Q_j	Rank
Vilnius	0.7055	1	Vilnius	0.6395	1	Vilnius	0.3981	1
Kaunas	0.3875	2	Kaunas	0.5551	2	Kaunas	0.2053	3
Klaipėda	0.2194	3	Klaipėda	0.5465	3\4	Klaipėda	0.1747	5
Šiauliai	0.1257	4	Šiauliai	0.5367	5	Šiauliai	0.2161	2
Panevėžys	0.1047	5	Pavevėžys	0.5522	3\4	Pavevėžys	0.1872	4

Table 5 displays the AS_i (appraisal score), P_i (relative closeness to the positive ideal solution), and Q_j (relative significance) values according to which the cities are ranked. After assessing the level of smartness of the five largest cities in Lithuania by applying multi-criteria assessment using three different methods, it was established that Vilnius is the smartest city. By applying the EDAS and TOPSIS methods, Kaunas is in second place in terms of smartness. However, the COPRAS method shows that Šiauliai is in second place. The third place is partly consistent in the EDAS and TOPSIS methods. With the COPRAS method, results are different. When using the COPRAS and TOPSIS methods, the fourth place is partly consistent, and it is established that Panevėžys is fourth in terms of smartness, but the EDAS method reveals that Šiauliai is fourth. With the three different multi-criteria assessment methods, the results of the fifth-place using the EDAS, TOPSIS, and COPRAS methods are radically different. Thus, after completing this study using various methods, it can be stated that the results obtained using different multi-criteria assessment methods are not consistent. This creates the assumption that each method has its advantages and disadvantages, internal logic, and examines and highlights a different aspect of the phenomenon being assessed. In order to see the whole picture more thoroughly, the results are depicted in Figure 3.

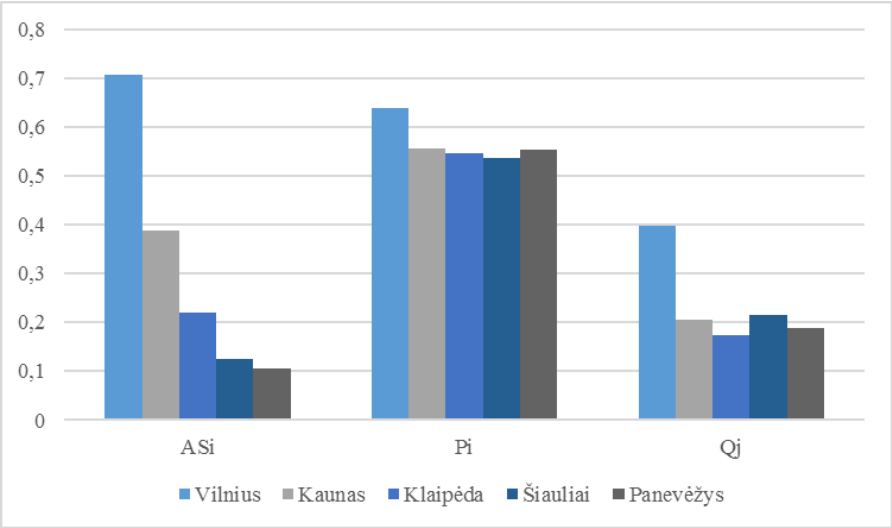

Fig. 3. Results obtained by applying multicriteria decision-making methods EDAS, TOPSIS, and COPRAS (Source: author's calculations)

As it could be seen from Figure 3, Vilnius is ranked as the smartest city in Lithuania. It could be explained by the fact that Vilnius is the capital of the Republic of Lithuania and is a leading city in attracting the most significant part of foreign direct investments. In fact, the ability to attract FDI is one of the drivers of cities' smartness (De Falco, 2019). Moreover, Vilnius significantly stands out with the number of universities, the number of IT companies and forest cover. This means that such different indicators working together could be crucial for cities transforming to the smart ones.

Conclusions

After performing the literature review, it was found that a smart city is described as a social and economic space in which governance and self-regulatory processes take place. This is an all-encompassing concept that fosters the use of innovations, with a focus on a knowledge-based society. A smart city is characterized by smart governance, smart economy, smart mobility, smart citizens, smart environment, and smart lifestyle. Smart cities are developed by implementing non-standard ideas and applying the principles of sustainable development. Smart city development involves people, diverse technologies, goods, businesses, communications, and energy. The development of smart cities is important because it helps build a knowledge-based society, conserves natural resources, creates a comfortable, functional and smart city, which results in easier access to information and services, reduced traffic flows, and higher-quality and more comfortable life.

The literature review shows that the creation and development of smart cities come with certain challenges. The problems of smart city development fall into three main categories. Social problems are related to the community and city residents, economic problems – to finances, and technological problems – to information systems.

The research to identify the smartest city consists of three main stages: determination of the criteria of smart cities, selection of cities, and identification of the smartest city. The study uses multi-criteria assessment methods: EDAS, TOPSIS and COPRAS. Quantitative multi-criteria methods for determining the level of city smartness allow for the ranking of alternatives according to various criteria that are rendered dimensionless.

After performing the multi-criteria assessment using three different methods, it is evident that the smartest city in Lithuania is Vilnius. Different multi-criteria assessment methods yield different results. Based on the EDAS method, Kaunas is in second place, Klaipėda is in third, Šiauliai is in fourth, Panevėžys is in fifth. Based on the TOPSIS method, Kaunas is in second place, Klaipėda and Panevėžys share the third and fourth places, and Šiauliai is in fifth place. The COPRAS method revealed that Šiauliai is in second place in terms of smartness, Kaunas, is in third place, Panevėžys is in fourth place, and Klaipėda is in fifth place.

The selected criteria for the assessment of smartness of a city could help assess other cities in other countries. However, to get more reliable results, the proposed criteria could be judged by experts – this would help to deal with one limitation of the current research and serve as an extension of it in the future. The article is based only on one-year data (the second limitation), so probably, the results could differ using more extended time series, and could help to have a more realistic view. In general, smart cities are associated with significant social, economic and environmental advantages to keep or develop the quality of life of citizens. Therefore there is an increasing interest of scientists and practitioners to find ways how not only to assess the status quo of cities but also to find prospects for their development.

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