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An Integrated Assessment of the Competitiveness of a Sustainable City within the Context of the COVID-19 Impact

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Abstract: It is crucial for a city to ensure economic stability and growth, along with social security and prosperity, not only for the present, but also for future generations. Increasingly, researchers are highlighting the need to apply sustainable urban growth principles to the field of urban development, arguing that this would reduce the negative impacts of urbanization processes (poverty, air pollution, unemployment, and crime). At the same time, cities are competing with one another to maintain their position in the urban hierarchy, not only in the short term, but also in the long term. The COVID-19 pandemic affected many areas of our everyday life: over 5.85 million deaths, increased unemployment, the introduction of restrictions, the closure of national borders, and various other circumstances have all undoubtedly affected to a certain degree those factors which serve to influence competitiveness. The aim of this article is to conduct an integrated competitiveness assessment of the Baltic capitals within the context of the impact of the COVID-19 pandemic for the period 2015–2020, according to an integrated assessment model for urban competitiveness (MDK), which is based upon the principles of sustainable development. A systematic and comparative analysis of the concepts published in the scientific literature has been performed, the concepts of sustainable city and sustainable urban competitiveness have been formed, research and methods of urban competitiveness evaluation have been carried out, and a comprehensive competitiveness assessment of the results of the study showed that the evaluation of integrated competitiveness of a sustainable city in the context of the impact of COVID-19 (using the Baltic capitals as an example in the period 2015–2020), in terms of the multi-criteria SAW and TOPSIS evaluation methods, is in the highest position in 2016–2019. Vilnius is in second place during the whole period 2016–2019. Riga takes third place in 2015–2019 (except in 2020, when it exchanges places with Vilnius and takes second place). Meanwhile, the results of the COPRAS multicriteria method differ from those discussed above. In 2016, 2019, and 2020, Tallinn is in the highest position, and in 2015, 2017, and 2018, it is surpassed by Vilnius. Riga remained in third place from 2015 to 2019. In 2020, Vilnius took over this position.

Keywords: sustainable city; urban competitiveness; impact of COVID-19 pandemic

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1. Introduction

The past couple of years has been difficult due to the COVID-19 (respiratory disease that started in December 2019 and spread worldwide) pandemic, which continues to be a threat to our health, even today. Not only has the healthcare system and businesses in general suffered, but everyone individually has also suffered to varying degrees. Employees have been forced to work in solitude and isolation, communicating less with each other transitioning to remote working. Everyone's daily routines and habits underwent enforced levels of change. People were forced to spend long periods of time at home, and some services were banned due to the general restrictions which had to be imposed. Within the EU, the unemployment rate was recorded at 8.65% in August 2020.

The impact of the COVID-19 pandemic varied from one economic activity to another. According to the World Tourism Organization [1], tourism accounted for 7% of world trade in 2019 (although in some countries it accounts for around 20% of Gross Domestic Product (GDP), and is the third-largest export sector for the world economy overall). The tourism sector is one of the most heavily affected by the COVID-19 pandemic. International tourism fell by 74% in 2020, while passenger numbers decreased by 60%. In 2020, when compared to the figures for 2018, government final consumption expenditure increased by more than 23% in Lithuania, more than 12% in Latvia, and more than 15% in Estonia. Goods exports and services in 2020, if they were to be compared to the figures for 2018, increased only in Lithuania, by over 6%. In Latvia and Estonia, the figure was negative, a decrease of more than 0.5%. The import of goods and services decreased by around 5% in Lithuania. Latvia saw an overall decrease of about 3.5%, while Estonia's figure fell by more than 2%. Lithuania's unemployment rate rose the most out of all three Baltic States, by 37%, while in Estonia this figure increased by around 27%, and in Latvia by more than 9%. The changes which were caused by the COVID-19 pandemic and its impact on individual sectors and the economy as a whole are very clear to see.

When analyzing the COVID-19 pandemic indicators, it can be observed that Lithuania has the highest number of cases and deaths, while Estonia has the lowest. According to *Trading Economics*, Lithuania has the highest unemployment, inflation, public debt, and trade balance among the Baltic countries (see Table 1).

Table 1. Indicators which have been affected by the pandemic.

	Coronavirus Cases	Coronavirus Deaths	Unemployment Rate	Inflation Rate	Balance of Trade (Eur. Million)	Government Debt to GDP (percent of GDP)
Lithuania	891,538	8368	10.2	12.4	−410	47.3
Latvia	624,008	5191	6.6	7.4	−96.7	43.5
Estonia	483,955	2204	5.2	11.3	−199	18.2

The changes caused by the COVID-19 pandemic are only a comparison of several indicators. The authors of this article hope to evaluate the competitiveness of cities in a comprehensive way and to determine whether the position of urban competitiveness is changing precisely due to the consequences of the COVID 19 pandemic. One of the main limitations of this article is the availability of data. The aim of this article is to assess the competitiveness of the Baltic capitals within the period 2015–2020 and within the context of the impact of COVID-19.

The article consists of three parts. The first part describes an analysis of the scientific literature that was performed, defining the concepts: sustainable city, sustainable development, and competitiveness of a sustainable city. Methods for assessing the competitiveness of the city are reviewed. The second part describes the research methodology. The third part describes the results of the study.

2. An Analysis of Relevant Literature

Researchers have been, and still are, studying the impact of the pandemic on different areas of our life [2–4] taking into account the issue of worker welfare. The sustainability where it concerns workers and the challenges being posed by undertaking remote working has been widely studied within the context of the COVID-19 pandemic, notably by [5–8], while the impact of the pandemic upon the tourism sector has been studied by [9–12], and business competitiveness levels by [13,14]. Different sectors, such as the export area [15] and the transport sector [16], have also been looked at.

2.1. The Concept of a Sustainable City and Sustainable Development

In 2020, a total of 4.35 billion people were recorded as living in urbanized areas, and 3.40 billion lived in rural areas. In 2050, it is projected that around 68% of the population will live in urbanized areas. The growth of urbanization poses major problems for cities in terms of crime, unemployment, and poverty, with air pollution being one of the biggest of those problems. According to information from the 'World Air Quality Report', as much as 90% of the world's population were breathing polluted air in 2019 [17]. Based on the details contained within this report, countries around the world are ranked according to their concentrations of $PM_{2.5}$ ($\mu g/m^3$) particles in the air. The highest concentrations are to be found in Bangladesh, Pakistan, and India. Air pollution can be linked to 11.65% of deaths worldwide. It is also one of the main risk factors for various diseases and is at its highest in the lowest-income and middle-income countries. In order to combat these problems, the principles of sustainable development need to be implemented. A sustainable city should maintain a balance between ecological activity, social well-being, and pollution. The introduction of the principles of a sustainable city is a matter which has been emphasized in scientific literature [18–24], when looking at the concept of a smart city. Tan Yigitcanlar has argued that smart cities are one of those means by which cities can become sustainable, i.e., to create smart infrastructure by using smart forms of technology [25]. This means that smart city programs should focus upon technology in order to be able to develop solutions for environmental, social, economic, and governance-related challenges [26]. To understand sustainability in cities, it is necessary to explore it at different levels and from multiple perspectives [27,28]. It is also necessary to understand the sustainable city from the perspectives of the various actors that are embedded in it [28,29].

Sustainable urban development involved the process of improving the quality of life in a city, including in terms of its ecological, social, and economic components, without leaving a burden on future generations. The question is, however, when can a city be considered sustainable? There are different views regarding that particular point in scientific literature. Some researchers assess urban sustainability in terms of certain aspects, including the following: environmental sustainability [30], the sustainability of businesses [31], the sustainability of tourism [32], the sustainability of higher education [33], the sustainability of land use [34], and the sustainability of public transportation [35]. Everyone, however, agrees that economic growth, social progress, and environmental protection are essential for urban sustainability. Pieterse stressed that effective policies that are based upon sustainable development principles are crucial for the sustainable development of cities [36]. Therefore, in light of recent research on the development of sustainable cities, it can be argued that it is important to consider sustainable urban development in four components: economic, social, environmental, and urban governance, rather than concentrate on the usual three.

In the same way, researchers seek to define the assessment of a sustainable city by developing assessment models which serve to identify interactions between different factors. Li presented a model which could be used for linking urban-industrial integrated land-use efficiency levels and the accessibility of the highway network, which aimed to determine how urban-industrial land-use efficiency levels can influence the city's ecological environment, plus the accessibility of the highway network [37]. The model which was used here for the integrated assessment of urbanization is able to identify several subsystems, namely: population; land; and economic, social, and comprehensive urbanization [38]. Cui presented an integrated assessment of the city in terms of its socio-economic and water environment [39]. Xiao conducted an urban assessment between built-up, heavily used land and demographic socioeconomic urbanization [40]. In the assessment of a sustainable city, researchers combined population, land, and industry within the assessment model [41]. Sun evaluated urban infrastructure from the perspectives of economic, social and environmental perspectives [42]. In assessing the sustainability of a city, it has been discovered that there is an inverse 'U' relationship between economic growth and environmental protection [43], between telecommunications infrastructure and economic growth [44], and between electrical consumption and economic growth, all within both the short term and the long term [45]. Concentrations of dangerous particles of PM_{10} increase in line with increasing road widths, but road length does not seem to be a significant factor [46]. It was also realized that there is an indirect relationship between the green economy and openness, and that investments in research do not affect the growth of the green economy. However, this area may still have an impact in the long term.

One of the reasons why it is necessary to assess urban sustainability levels is the development of a municipal strategy with an emphasis on ensuring the efficiency of ecological, social, and environmental systems [47]. However, it should not be forgotten that cities are constantly in competition with one another, seeking to gain and maintain a position within the hierarchical structure.

2.2. The Competitiveness of a Sustainable City

Previous research [48,49] has confirmed that cities compete at international, national, and regional levels. What is more, they usually compete for the same objectives: to be attractive for businesses, residents, investors, tourists, national and/or international projects, and so on. Various scientific work has tended to aid in explaining the competitiveness of cities in different ways, depending upon the purpose of the study in question, along with the overall context and the author's individual or collective point of view. Despite the various available definitions of urban competitiveness which have been provided by different authors, it is important to view urban competitiveness itself as a change in competitive position over time, and in relation to other cities in the national and international urban system. Scientific literature identifies a number of different determinants when it comes to analyzing competitiveness. Urban infrastructure has a positive impact on the economic, social, and environmental framework of a city [50]. Investment in urban infrastructure development tends to stimulate the development of other industries and thereby increases the city's GDP [51–53] thereby also increasing the consumption expenditure of the population [54,55]. An expanded urban infrastructure is a factor which serves to boosts exports [56]. Urban infrastructure also influences the creation of new jobs, thereby increasing the level of employment within the city [57], and, thereby, also increasing disposable income. It also has a positive impact on the education and health systems [58,59]. Recently, there has been an increasing focus on the less tangible determinants of competitiveness (such as human capital, competence areas, responsiveness, smartness, and so on) as the most important areas in light of the opportunities and peculiarities that are being offered by globalization. Scientific literature classifies those factors which serve to provide an influence upon competitiveness in different ways: unique factors (internal, which also includes management quality), external factors [60], and also economic and strategic factors [61]. Webster and Muller classify competitiveness factors into four groups: economic structure; territorial distinctiveness; human resources; and institutional and cultural environment [62]. Landry [63] highlighted the economic viability of cities as a new factor in urban competitiveness. Kusakci (2022) used the hybrid IT2F-AHP and COPRAS method for the assessment of sustainable metropolitan areas in Turkey [64]. The OECD [60] stressed that the competitiveness of cities and regions, along with economic growth and the development of innovation, are all closely interlinked topics.

Although various researchers use different methods to identify and classify the different factors which serve to determine competitiveness, they all agree that a city's competitiveness is not determined by one single factor, or even a few factors, but by many factors which interact with each other. An integrated assessment of competitiveness is therefore necessary. The same researchers also recognize the fact that the determinants of urban competitiveness vary from city to city, depending upon a wide range of internal and external characteristics. They have found that each city needs to find its own unique determinants of competitiveness, and that each city also needs to strengthen and leverage those determinants in its competition with other cities.

2.3. Assessing a City's Competitiveness

The available scientific literature provides a wide variety of methods and classifications when it comes to working out how to assess cities [65–68]. In addition to that, the available scientific literature also presents and describes assessment methods, complex indices, and empirical studies. Some of these include the following: a study of smart cities, using the example of Amsterdam and London [69]; an assessment of the competitiveness of Lithuanian cities [66,70,71]; an integrated assessment of the competitiveness of the Baltic capitals based on sustainable development principles [68]; an assessment of social environmental competitiveness in terms of security in the Baltic capitals [72]; ranking priorities amongst the Baltic capital cities in terms of the development of sustainable construction [73]; the Lisbon ranking for smart sustainable cities in Europe [74]; a multi-criteria evaluation of smart performance in European cities: economic, social, and environmental aspects [75]; in search of the 'smart' source of the perception of quality of life in European smart cities [76]; determining those factors which form part of becoming a sustainable smart city: an empirical study in Europe [77]; military and demographic interlinkages within the context of Lithuanian sustainability [78]; and an evaluation of the impact of bypasses on air pollution reduction: the case of Vilnius [79].

Cities compete with one another for the reasons discussed above. The aim of this article is to carry out an integrated competitiveness assessment on a sustainable city within the context of the impact of COVID-19 (using the example of the Baltic capitals in the period 2015–2020). The limitations of the study include the availability of data (the COVID-19 pandemic remains ongoing, so the assessment only covers part of the pandemic period).

3. Methodology

Činčikaitė's model [71] for the integrated assessment of urban competitiveness (MDK), which is based on the principle of sustainable development, groups factors into three levels. Level 1 being baseline factors (i.e., those without which a city would not be able to exist. They are particularly important for the city's economic, social development and environmental quality), Level 2 being development factors (these include factors which directly created the city's welfare, and, at the same time, through the measures which enable to effectively use the basic factors, form the competitiveness of the city), and Level 3 being interactions (which reflect the result developed by the basic factors and development factors) (see Figure 1).

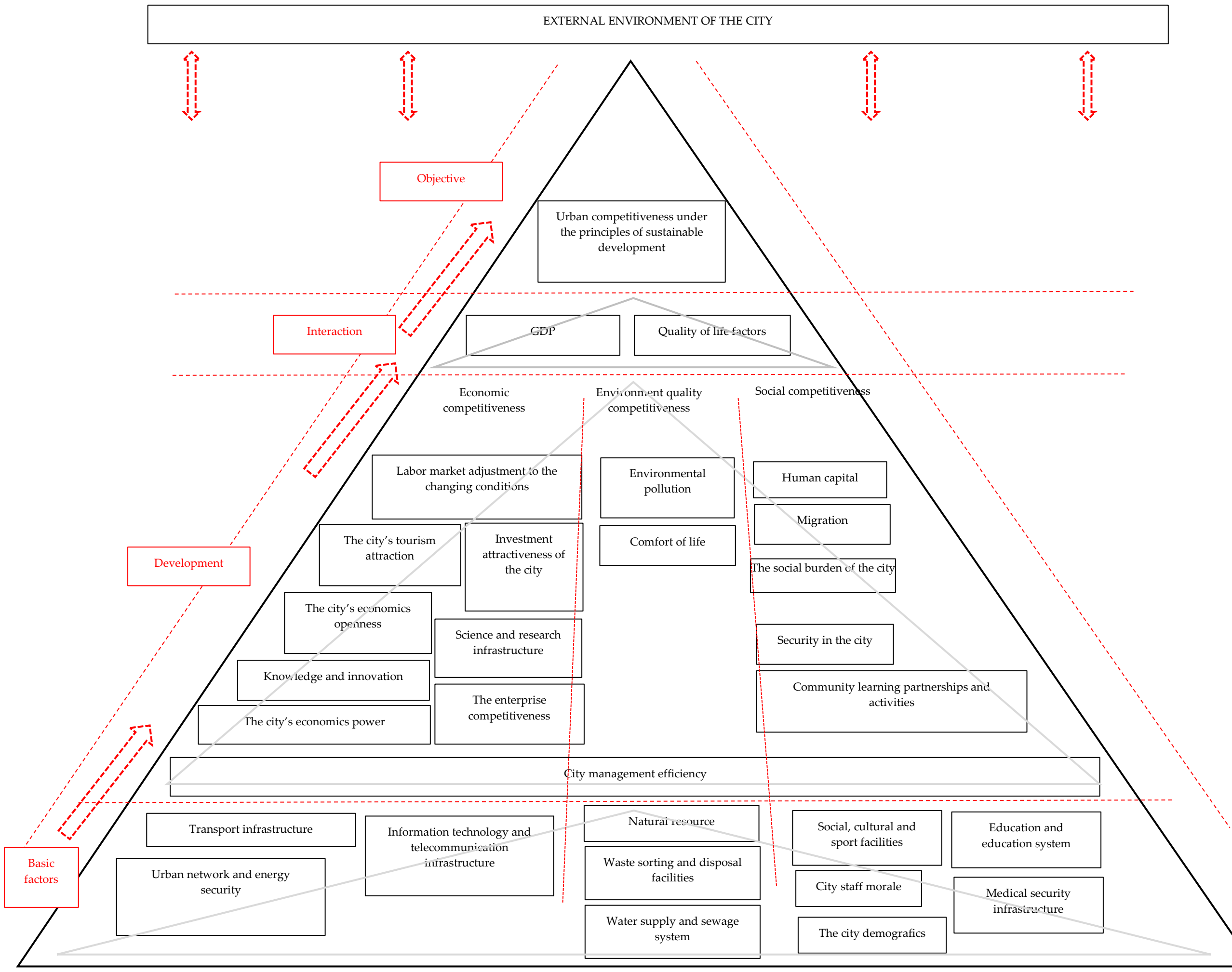


Figure 1. The model of urban competitiveness measurement under the principles of sustainable development.

The factors which have been identified are structured according to the components of sustainable development (a viable and competitive economy, a healthy environment, social well-being, and ecology). The external environment is also identified in the model.

The value of urban competitiveness (M40) is calculated according to Function (1):

$$M_{40} = F(w_{31}, M_{31}, w_{50},\ M_{50}, w_{10}, M_{10}, w_{20}, M_{20}) \quad (1)$$

where:

M_{40}—the city's estimate of sustainable competitiveness;

$w_{1\ldots n}$—are the weighting factors.

M_{31}—an estimate of the interaction level factors (GDP and urban quality of life);

M_{50}—is an estimation of the city's external environment (such as economic, social, political, and environmental factors).

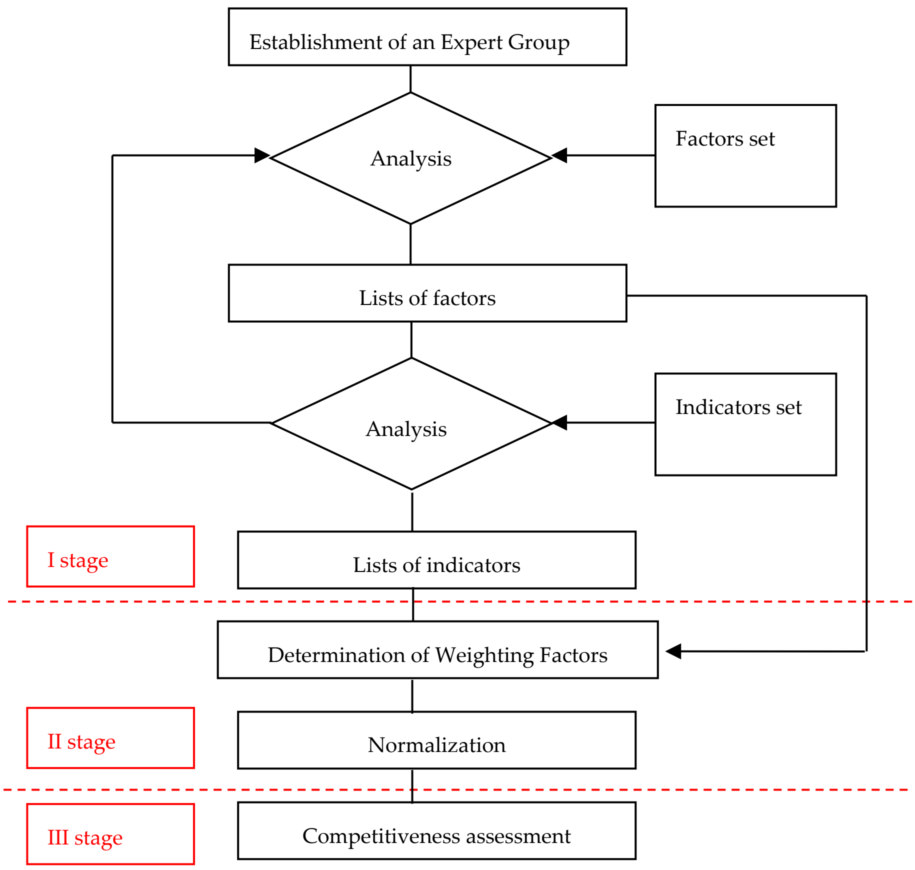
M_{10}—an estimation of the base level factors (the value of the factor that covers urban transport infrastructure; the value of the factor that covers information technology and telecommunications infrastructure; the value of the urban demographic factor; the value of the social, cultural and sports infrastructure factor; the value of the health infrastructure factor; the value of the wastewater treatment system factor; and the value of the education and educational system factor).

M_{20}—is an estimation of development level factors (the value of the factor which covers the city's economic power; the value of the factor which covers the competitiveness of businesses within the city; the value of the factor which covers the city's level of attractiveness to tourists; the value of the factor which covers the city's investment attractiveness; the value of the factor which covers the adaptation of the labor market to the changing conditions; the value of the factor which covers the level of comfort for those who are living in the city; the value of the factor which covers pollution in the environment; the value of the factor which covers human capital; the value of the factor which covers migration; and the value of the factor which covers security in the city; and the value of the factor which covers learning, partnership, and the active participation of communities).

The algorithm for assessing the competitiveness of cities based on the principles of sustainable development consists of three stages (Figure 2):

1. A group of experts is formed, which, after performing the analysis, selects the factors for the research from the set of factors presented. Once the factors lists have been drawn, the expert group performs an analysis and selects indicators based on its results. The result of this stage is the compilation of lists of factors and indicators;
2. Data normalization is performed;
3. Estimation of urban competitiveness is calculated using multicriteria evaluation methods (SAW (Simple Additive Weighting–SAW), COPRAS (Complex Proportional Assessment-COPRAS), TOPSIS (Technique for Order Preference by Similarity to Ideal Solution–TOPSIS)). The results obtained are analyzed, and problematic areas and factors of sustainable urban development are identified. Projects can be started to improve identified problematic factors.

It is necessary to assess the competitiveness of cities in accordance with the following principles: to define the city to be assessed; assess in detail each factor of competitiveness; and include only those that have the greatest impact on the competitiveness of the city.



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Indicators to describe the factor are selected using correlation regression analysis. Data were obtained from statistical databases (Eurostat and the databases of the Lithuanian, Latvian, and Estonian statistical departments)

The researchers who conducted the study used three multi-criteria assessment methods and compared their results with each other:

The SAW method ('Simple Additive Weighting') is a simple and commonly used solution for multiple attributes. The method is based on a weighted average. The evaluation score for each alternative is calculated by multiplying the scale assigned to the alternative for that attribute by the relative weights assigned directly by the decision maker and then summing the products of all the criteria. The advantage of this method is that it is a proportional linear transformation of the raw data, which means that the relative order of magnitude of the standardized scores remains the same ([73,80,81]) (2):

$$S_j = \sum_{i=1}^{m} w_i \widetilde{r_{ij}} \tag{2}$$

where:

S_j is the multi-criteria assessment value of the j-th alternative;

ω_i is the weight of the i-th indicator;

r_{ij} is the normalized value of the i-th indicator for the j-th alternative The normalization of the initial data is carried out according to Formula (3) [80,82]:

$$\widetilde{r_{ij}} = \frac{r_{ij}}{\sum_{j=1}^{n} r_{ij}} \tag{3}$$

where:

r_{ij} is the value of the i-th indicator for the j-th object.

The COPRAS method allows us to cover several evaluation objects, which are characterized by both maximizing and minimizing indicators, defining integral criteria (determined according to the respective groups of primary criteria) and determining the value of the summative criterion. This method evaluates the influence of maximizing and minimizing criteria on the generalized result separately. The COPRAS method ('Complex Proportional Assessment') is used to normalize the data by transforming them [83] into a dimensionless form according to the following Formula (4):

$$\widetilde{r_{ij}} = \frac{r_{ij} w_i}{\sum_{j=1}^{n} r_{ij}} \tag{4}$$

The prioritization of objects is established. The higher the Q_j value, the higher the efficiency (priority) of the option (5).

$$Q_j = S_{+j} + \frac{S_{-min} \times \sum_{j=1}^{n} S_{-j}}{S_{-j} \times \sum_{j=1}^{n} \frac{S_{-min}}{S_{-j}}} \tag{5}$$

where:

S_{-j} is the minimization index;

S_{-min} is the the lowest value of the minimization index.

The degree of utility N_j for option a_j is determined according to Formula (6):

$$N_j = \left(Q_j \div Q_{max}\right) \times 100\% \tag{6}$$

TOPSIS using the principle that the selected alternatives must have the shortest distance from the positive ideal solution and the furthest distance from the negative ideal solution from the geometric point, using the Euclidean distance to determine the relative proximity of the alternative to the optimal solution. A positive ideal solution is defined as the sum of all the best values that can be achieved for each trait, and a negative ideal solution is defined as the sum of all the worst values for each trait. TOPSIS takes into account both the distance to a positive ideal decision and the distance to a negative ideal decision, given the relative proximity to a positive ideal decision. Based on a comparison of relative distances, an alternative order of priorities can be achieved. This method is widely used to complete decision making. This is because the concept is simple, easy to understand, efficient to calculate, and has the ability to measure the relative performance of an alternative solution. TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method calculation steps [84]:

The difference between the positive ideal solution (see Formula (7)) and the negative ideal solution (see Formula (8) is calculated below:

$$s_i^+ = \sqrt{\sum_{j=1}^{n}\left(v_{ij} - v_j^+\right)^2} \tag{7}$$

Here:

s_i^+ is the alternative distance from the positive ideal solution, where i = 1, 2, 3, . . . , m;

v is the normalization of the weight matrix.

$$s_i^- = \sqrt{\sum_{j=1}^{n}\left(v_{ij} - v_j^-\right)^2} \tag{8}$$

Here:

s_i^- is the alternative distance from the negative ideal solution, where i = 1, 2, 3, . . . , m,

v is the normalization of the weight matrix.

The calculation of the positive ideal solution uses this function (see Formula (9)):

$$CC_i^+ = \frac{s_i^-}{s_i^* + s_i^-} \tag{9}$$

Here:

$CC_i{}^+$ is the positive ideal solution;

s_i^+ is the alternative distance from the positive ideal solution;

s_i^- is the alternative distance from the positive ideal solution;

The alternative rank is obtained. The alternative C^+ is ranked from the highest value to the lowest value. The alternative which has the highest value of C^+ is the best solution.

4. Study Results

The integrated competitiveness assessment of a sustainable city within the context of the impact of COVID-19 was carried out using the example of the Baltic capitals in the period 2015–2020. Vilnius, Tallinn, and Riga were chosen for their historical, cultural, and economic similarities. According to the 'European Cities SDG Index' (2019), Tallinn is ranked twenty-ninth, Vilnius thirty-third, and Riga thirty-sixth in this index. SDGs are analyzed as follows: using a score of '1′ when it comes to eradicating poverty in all its forms in all countries; '2′ to eradicate hunger, and to ensure food security and improved nutrition, while also promoting sustainable agriculture; '3′ to ensure healthy lifestyles and promote the well-being of all age groups; '4′ to ensure the provision of inclusive and equitable, high-quality education and to promote lifelong learning; '5′ to achieve gender equality and the empowerment of women and girls; '6′ to ensure access to water, sustainable management, and sanitation for all; '7′ to ensure access to affordable, reliable, sustainable, and modern energy for all; '8′ to promote sustained, inclusive, and sustainable economic growth, productive employment, and decent work; '9′ to build up a resilient infrastructure, to promote inclusive industrialization, and to encourage innovation; '10′ to reduce inequality between and within countries; '11′ to make cities and human settlements inclusive, safe, resilient, and sustainable; '12′ to ensure sustainable consumption and production patterns; '13′ to take urgent action to tackle climate change and its various forms of impact; '15′ to protect, restore, and promote the sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse the degradation of the land, and halt the loss of biodiversity; and '16′ to promote peaceful and inclusive societies for sustainable development, empower all when it comes to being able to demand justice, and in terms of building effective, accountable, and inclusive institutions at all levels. When analyzing SDGs, it can be seen where individual cities have an advantage in regards to certain sustainable development goals (see Table 2).

Table 2. An assessment of cities according to SDGs. The table is based on information which has been provided via: https://euro-cities.sdgindex.org/#/, (accessed on 2 March 2022).

Sustainable Development Goals (SDGs)	1	2	3	4	5	6	7	8	9	10	11	12	13	15	16
	Score, %														
Tallinn	68.7	43	69.4	56.2	40.5	95.3	25	89.1	37.7	68.3	57.5	64.9	46	52.9	73.3
Vilnius	41.6	27.2	60.7	51.7	63	97.1	25	82	26.8	56.5	48.9	88.5	46	56.7	42.2
Riga	50.6	35.6	58	53.9	51.6	93.7	25	84.2	26.9	64.5	45.5	52.9	46	63.3	46.2

Based on the model of integrated assessment of urban competitiveness based on the principle of sustainable development (MDK), an assessment of the Baltic capitals in the period 2015–2020 is performed, the aim of which is to determine the competitive positions of cities, their change, and to identify the factors determining change. The following factors determining competitiveness are included in the assessment of the city's integrated competitiveness (see Formula (1)).

In order to be able to carry out an integrated assessment of the competitiveness of a sustainable city within the context of the impact of COVID-19 (using as an example the Baltic capitals in the period 2015–2020), information was collected from several databases (namely *Eurostat* and the databases of the departments of statistics in Lithuania, Latvia, and Estonia). Both statistical and expert evaluation methods are used to assess the competitiveness of the Baltic capitals. Their outcome is determined by the availability of information. During the expert evaluation study, ten people were interviewed who were involved in strategic planning, regional development, and the promotion of the socio-economic development of the regions. The overlap was high between the opinions of those experts who were included in the survey, as measured by the Kendall correlation coefficient, where W is also high (W = 0.75). Using the model for assessing the competitiveness of cities (MDK), which is based on the principles of sustainable development, the factors are grouped into three levels and are structured according to the components of sustainable development (see Formula (1)).

When evaluating the results of the level I SAW method (see the Figure 3), it was observed that the most significant gap between the cities was observed in 2015 (the city of Vilnius), and from 2018 on this level the results of the cities are very close. It has also been observed that there is no significant change due to the COVID-19 pandemic. It can be concluded that cities have dealt with the effects of the pandemic in the same way, or that the impact of the pandemic on this level of factors is not significant or has not yet manifested itself.

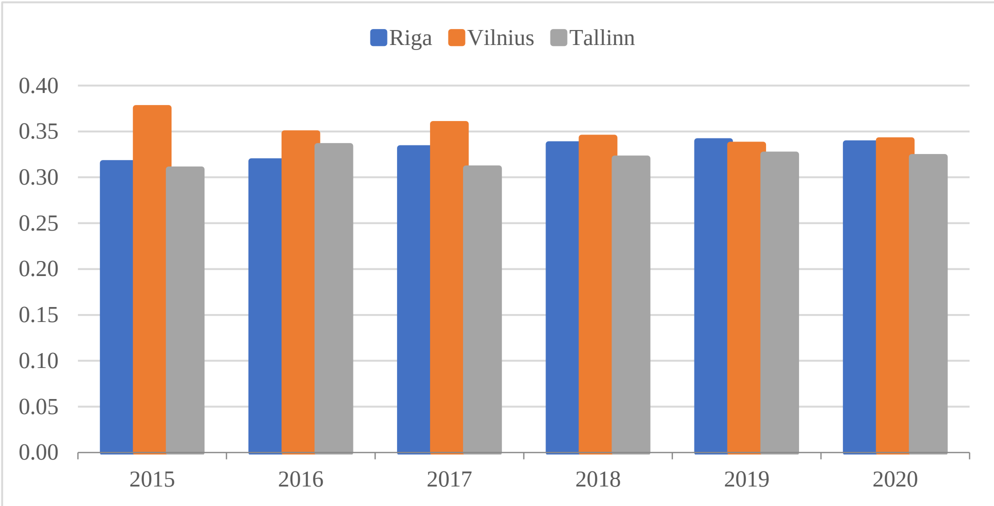

Figure 3. Results of Level I evaluation by SAW method.

Assessing the results of the Level II SAW method (see the Figure 4), it was observed that the city of Vilnius is far from other cities during the whole period under review (2015–2020). Here, it can already be noticed that in 2019–2020, the level II positions changed, and Tallinn took the third position. The results of the evaluation of the city of Riga in 2020 were the closest to the city of Vilnius. Riga was superior in 2020 in terms of investment attractiveness, labor market adaptation to changing conditions, population migration, knowledge and innovation, and human capital.

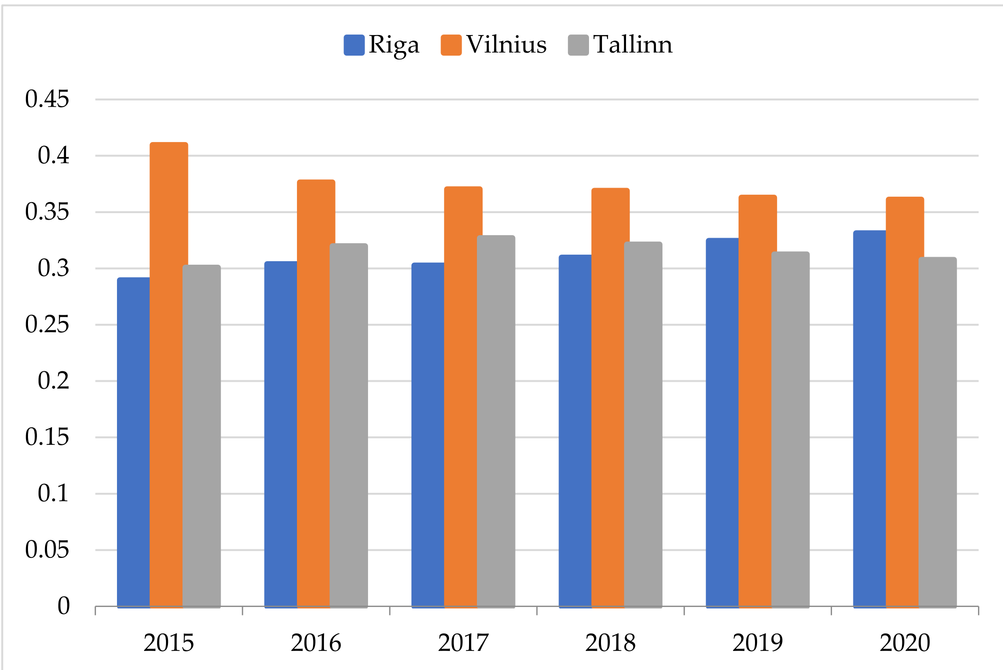

Figure 4. Results of Level II evaluation by SAW method.

Assessing the results of the Level III SAW method (see the Figure 5), it was observed that Tallinn is far from other cities during the whole period under review (2015–2020). In 2015–2019, the positions between Vilnius and Riga changed insignificantly, but in 2019–2020 the positions remained unchanged, but the gap widened. Riga had the largest gap with Vilnius during the whole period under review.

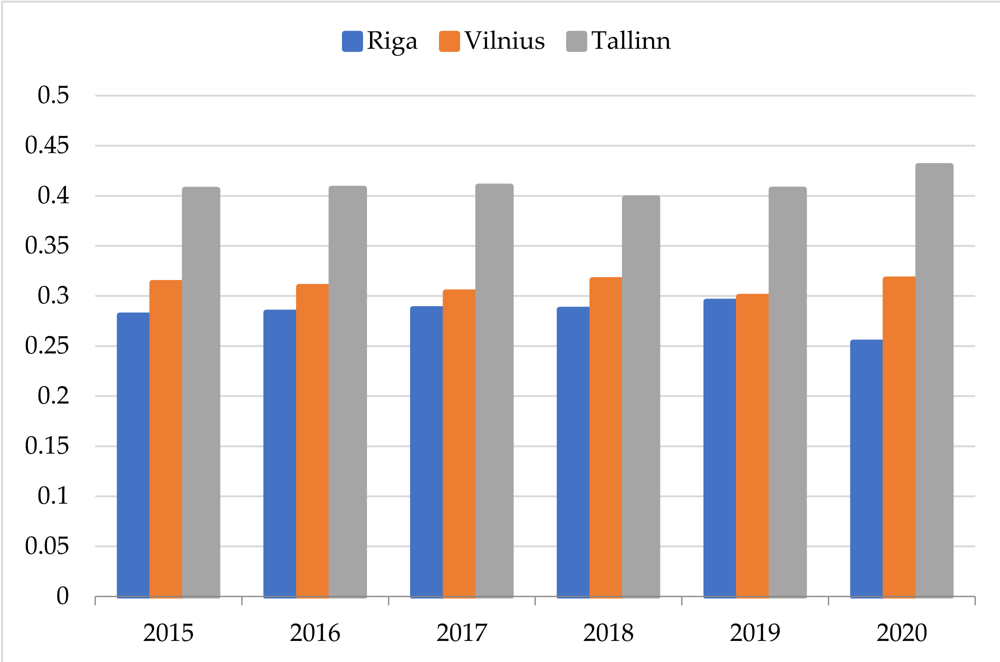

Figure 5. Results of Level III evaluation by SAW method.

Figure 6 shows that, from the point of view of the use of the SAW method, Tallinn, starting in 2016, took up the best position in terms of the integrated competitiveness of a sustainable city within the context of the impact of COVID-19 in the period 2015–2020 (Vilnius held this position in 2015). Riga remained in third place from 2015 to 2019. In 2020, Vilnius took over this position.

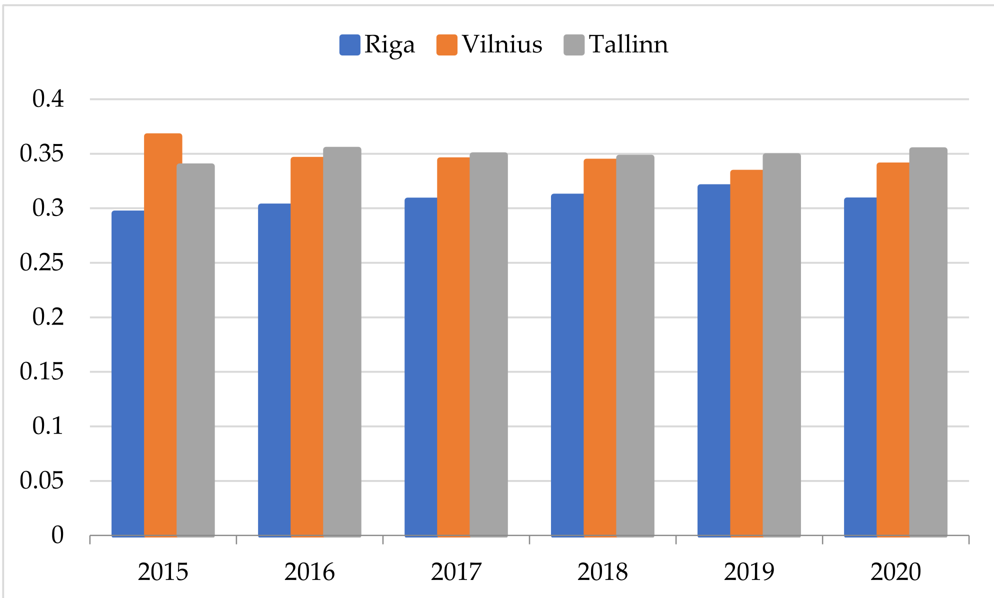

Figure 6. Results were obtained using the SAW method.

Figure 7 shows that from the point of view of using the COPRAS method, in 2016, 2019, and 2020, Tallinn took up the best position in terms of the integrated competitiveness of a sustainable city within the context of the impact of COVID-19 in the period between 2015–2020 (in 2015, 2017, and 2018, this position was held by Vilnius). Riga remained in third place from 2015 to 2019. In 2020, Vilnius took over this position.

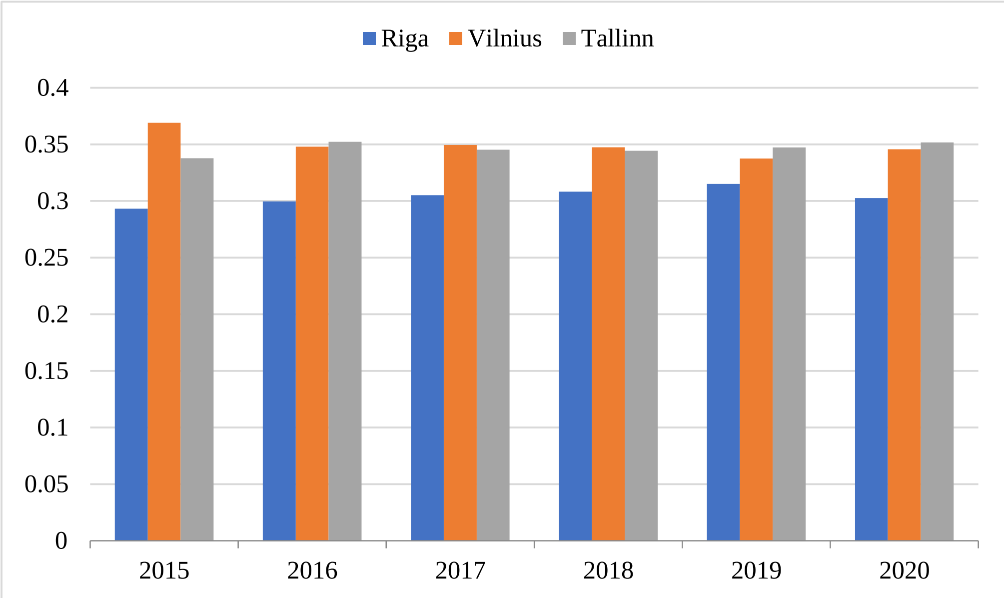

Figure 7. Results have been obtained using the COPRAS method.

Figure 8 shows that, from the point of view of the use of the TOPSIS method, in 2016–2020 Tallinn took up the best position in terms of the integrated competitiveness of a sustainable city within the context of the impact of COVID-19 in the period 2015–2020 (Vilnius held this position in 2015). Riga remained in third place from 2015 to 2019. In 2020, Vilnius took over this position.

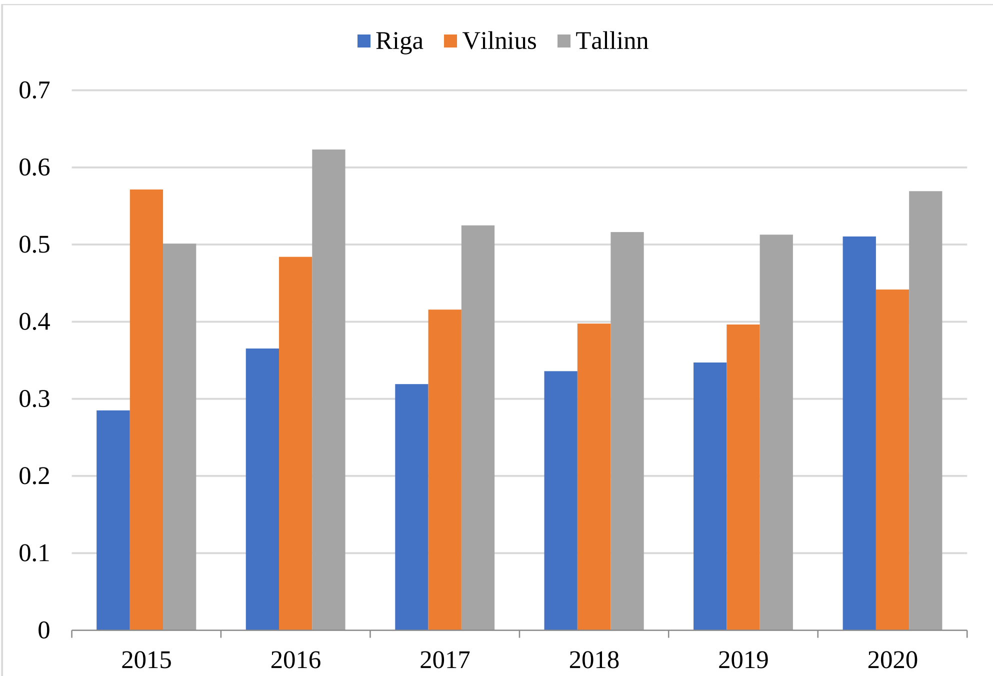

Figure 8. Results were obtained using the TOPSIS method.

The assessment of the integrated competitiveness of a sustainable city within the context of the impact of COVID-19 (using the Baltic capitals within the period between 2015–2020 as an example, see the Table 3), based on the MDK model using the SAW and TOPSIS multi-criteria assessment methods, shows that Tallinn is in top position in the years 2016–2019. Vilnius is in second place throughout the period 2016–2019. Riga ranks third in 2015–2019 (except for 2020, when it swaps places with Vilnius and ranks second). Meanwhile, the results from the COPRAS multicriteria method differ from those discussed above. In 2016, 2019, and 2020, Tallinn is in the top position, while in 2015, 2017, and 2018 it is overtaken by Vilnius. Riga remained in third place from 2015 to 2019. In 2020, Vilnius took over this position. Based on the results of the multi-criteria assessment, the Baltic capitals were ranked, and the average of the results from all of the methods which were used (SAW, COPRAS, and TOPSIS) was subsequently derived (see Table 2). The change between second and third positions took place in 2020. From all of this, it can be concluded that Riga has handled or is 'handling' the COVID-19 pandemic better than Vilnius. Tallinn's position, which changed in 2016, remains dominant, but it has been observed that it dropped to second place in 2017 and 2018 using different assessment methods.

Table 3. Average city ranks.

	2015	2016	2017	2018	2019	2020
Riga	3	3	3	3	3	2
Vilnius	1	2	1.67	1.67	2	3
Tallinn	2	1	1.33	1.33	1	1

5. Discussion

Cities are ranked according to differently-calculated indices. A number of them have been developed, some of which are presented in Table 4.

Table 4. Ranking Baltic capitals by different indices in 2021 [1].

City	Quality of Life Index	Natural Disaster Risk	Healthcare Index	Cost of Living Index	Property Price to Income Ratio	Pollution Index	Crime Index
Tallinn	168.65	2.36	71.28	59.20	9.74	22.58	22.50
Vilnius	165.21	3.31	75.10	48.79	11.05	23.50	27.59
Riga	142.27	2.92	60.73	55.43	9.59	38.34	37.93

[1] Table is based on information which was provided via: www.numbeo.com, (accessed on 13 March 2022).

As can be seen from Table 4, different indices show different positions for the three cities, depending upon the purpose of the index, the indicators being used, and the methods being used. Scientific literature also provides a wide range of methods being used in order to assess cities, as well as examples of their application [62,66–75].

The authors of this article have carried out an integrated competitiveness assessment of sustainable cities within the context of the impact of COVID-19 (using as an example the three Baltic capitals within the period 2015–2020). Further research could include an assessment of the competitiveness of the economic environment or the competitiveness of different regions in order to identify their strengths and weaknesses and their trends over time. Furthermore, when taking into account today's breaking news, it would now be possible to anticipate the assessment and trends of countries in and around the war zone.

6. Conclusions

1. In light of recent research on the development of sustainable cities, it can be argued that it is important to consider sustainable urban development in four components: economic, social, environmental, and urban governance. This means avoiding use of

the usual three components. The assessment of the competitiveness of a sustainable city is a tool that can be used to identify the strengths and weaknesses of cities and to support the preparation of municipal strategic plans;

2. However, while scientific literature provides a good many methods for assessing urban competitiveness, such a large number of such methods can lead to a considerable amount of controversy to concerning each of them where they are claimed as being as objective as possible when it comes to assessing said indicator. Some researchers have proposed that the competitiveness of cities be assessed by using as a basis one or more indicators, while others have developed theoretical models of urban competitiveness by combining a set of quantitative and qualitative indicators, and yet more researchers have used an index or various mathematical equations in their work.
3. The assessment of the integrated competitiveness of a sustainable city within the context of the impact of COVID-19 (using as an example the three Baltic capitals within the period between 2015–2020), based on the MDK model, which uses the SAW and TOPSIS multi-criteria assessment methods, shows that Tallinn retains the top position in the years between 2016–2019. Vilnius is in second place throughout the period 2016–2019. Riga ranks third in 2015–2019 (except for 2020, when it swaps places with Vilnius and ranks second). Meanwhile, the results from the COPRAS multicriteria method differ from those which have been discussed above. In 2016, 2019, and 2020, Tallinn occupies the top position, while in 2015, 2017, and 2018, it is overtaken by Vilnius. Riga remained in third place from 2015 to 2019. In 2020, Vilnius took over this position;
4. The position of cities in the rankings can change for a wide variety of reasons, leading to changes in the performance of certain factors. It is important once again to note that the study uses a specific model when it comes to providing an assessment of the competitiveness of cities (MDK) which is based on the principles of sustainable development and which groups the factors into three levels. Level 1 consists of the following: the importance of the factor which covers urban transport infrastructure; the importance of the factor which covers information technology and telecommunication infrastructure; the importance of the factor which covers urban demographics; the importance of the factor which covers social, cultural, and sports infrastructure; the importance of the factor which covers medical care infrastructure; the importance of the factor which covers the sewage system; and the importance of the factor which covers the education and training system. Level 2 consists of the following: the value of the factor which covers the individual city's economic power; the value of the factor which covers the competitiveness of businesses within the city; the value of the factor which covers the city's levels of attractiveness to tourists; the value of the factor which covers the city's attractiveness to investors; the value of the factor which covers the adaptation of the labor market to the changing conditions; the value of the factor which covers comfort of living in the city; the value of the factor which covers pollution of the environment; the value of the factor which covers human capital; the value of the factor which covers migration; the value of the factor which covers security within the city; and the value of the factor which covers learning, partnership, and the active participation of communities. Level 3 consists of the following: an estimation of GDP and quality of life in the city. The decomposition of the model helps to identify the drivers of change. It is obvious that the COVID-19 pandemic has affected a good many of these factors and has, therefore, created increased unemployment, higher public levels of debt, bankruptcies, and higher inflation; however, all of this is ongoing and, as the authors of the present article have previously mentioned, this assessment only covers part of the pandemic period. The change in the competitive position between Vilnius and Riga in 2020 was determined by Level II changes. Riga was superior in 2020 in terms of investment attractiveness, labor market adaptation to changing conditions, population migration, knowledge and innovation, and human capital.

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