SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2024
ORGANIZATION AND MANAGEMENT SERIES NO. 213

RANKING OF EUROPEAN CAPITALS BEFORE AND AFTER THE COVID PANDEMIC

Adam SOJDA

Silesian University of Technology, Faculty of Organization and Management, Department of Economics and Informatics; adam.sojda@polsl.pl, ORCID: 0000-0002-3021-4451

Purpose: The COVID-19 pandemic has introduced the population living in the cities to a new reality. The study aims to show how the perception of the inhabitants of European capitals and their cities has changed during this period.
Design/methodology/approach: Eurostat provides data from the Perception Survey on the Quality of Life in European Cities. The research is carried out every four years. The last two, 2019 and 2023, coincide with the COVID-19 pandemic. A Smart Index was built for 30 European capitals based on selected indicators from the database. The index is based on 34 indicators assigned to seven categories. On this basis, the differences in the assessment of cities before and after the pandemic were shown.
Findings: When comparing the indices of capitals, 11 recorded a decrease in ranking, 13 improved their position, and six remained unchanged.
Research limitations/implications: The study may be supplemented with objective factors in the future. However, it is based on residents' subjective assessments. It is difficult to assess the direct impact of the pandemic on residents' perceptions of the city, especially since the cyclical survey does not include questions related to the pandemic in the questionnaire.
Social implications: The study shows how the perception of key European cities has changed before and after the COVID-19 pandemic. It revealed which aspect of the town's assessment, according to the Smart City methodology, showed improvements and which showed declines. For the managers of these cities, this is an alarming signal indicating which aspects of development require their utmost attention.
Originality/value: The article proposes a Smart City Index based on residents' ratings for European capitals. To compare results from the two periods, a method of unification, considering the values from both periods, was proposed.
Keywords: Smart City Index, Eurostat, COVID-19.
Category of the paper: Research paper.

1. Introduction

In 2023, the degree of urbanisation worldwide was 57 percent. North America, Latin America, and the Caribbean had the highest level of urbanisation, about 83 percent. Next was Europe, with 75 percent. North America is the most urbanised continent, but Tokyo-Yokohama in Japan was the largest urban area in the world that year, with 37.7 million inhabitants.

The urbanisation process means that cities will play a key role in the development of humanity. One of the strategic goals of urban development is to ensure security and prevent situations that create a state of danger or crisis. The concept of Smart City is constantly being developed. We can distinguish five generations of development of this concept (Cohen, 2015; Svítek et al., 2020; Kinelski, 2022; Kuzior, 2024):

- Smart City 1.0 – the ICT sector offers its products for cities.
- Smart City 2.0 – cities are the initiators of ICT implementation.
- Smart City 3.0 – city residents take over the initiative to implement ICT solutions.
- Smart City 4.0 – the sharing of knowledge about modern technologies ensures sustainable development of urban areas and their inhabitants.
- Smart City 5.0 – a multi-agent ecosystem of smart services allows for a harmonious balance of various aspects of residents' lives.

The diversity of the approach to a Smart City has allowed us to understand the dimensions of a Smart City table 1.

Table 1.
Dimension of Smart Cities

Dimension	Description
Government	Interaction between the city authorities and all stakeholders – citizens, entrepreneurs, civil society organisations
Economy	Actions aimed at transforming and strengthening the city's economy
Environment	Environmental management to improve living standards and reduce civilisation pollution
Living	Improving quality of life, social and digital exclusion, safety and care
Mobility	Urban transport services, improving the flow of people, goods and services in the city
People	Appropriate forms of education, career opportunities in labour markets

Source: (Cohen, 2015; Giffinger, Gudrun, 2010; Marchlewska-Patyk).

Table 2.
Smart Cities Index

Selected Smart City Index	Number of cities	1st	2nd	3rd
Cities in Motion Index	74	London	New York	Paris
Global E-Governance Survey	100	Seoul	Madrid	Yerevan
Innovation Cities Index	500	Tokyo	Boston	New York
Smart City Governments	235	Singapore	Seoul	London
Smart Cities Index	500	Oslo	Bergen	Amsterdam
Smart City Index	118	Singapore	Zurich	Oslo

Source: Own research based on (Lai, Cole, 2023).

In addition to the presented list, there are other rankings (Akande et al., 2019; Pangsy-Kania, Kania, 2024; Roland Berger, 2019; Toh, 2022; Vanli, 2024).

The COVID-19 pandemic swept the world from 2019 to 2023. The population living in cities was most exposed to it (Kozak, 2022; Warszawski, Mikucki, n.d.)The study aims to show how the perceptions of the inhabitants of European capitals and their cities have changed over this period.

2. Data structure

The Perception Survey on the Quality of Life in European Cities. was conducted in 79 European cities. It covered all capitals of the countries studied (except Switzerland) and one to six additional cities in larger countries. About 500 residents were interviewed in each city, and 835 interviews were collected in each city. Targets were set at a minimum of 100 online interviews per city and a maximum of 735 via telephone. In some cities, more online interviews were collected.

The availability of data in terms of cities and questions was compared. The following capitals were received: Amsterdam, Ankara, Athens, Berlin, Bratislava, Brussels, Bucharest, Budapest, Copenhagen, Dublin, Lisbon, Ljubljana, London, Luxembourg, Madrid, Nicosia, Oslo, Paris, Prague, Reykjavik, Riga, Rome, Sofia, Stockholm, Tallinn, Valletta, Vienna, Vilnius, Warsaw, Zagreb. Not all capitals can be considered strictly European, but it was decided that they should be left in the study due to their membership in the EU or NATO community.

Due to the specificity of the available data, new areas of city assessment have been defined.

- **ECONOMY** (ECO) – questions about work, real estate prices, the financial and material situation of the household.
- **ENVIRONMENT** (ENV) – assessments of green space, noise and air quality.
- **GOVERNANCE** (GOV) – assessment of satisfaction with solving local problems, procedures applied by the city authorities, information and administrative services, corruption of local authorities.
- **HUMAN CAPITAL** (HUC) – sports and cultural activities as well as facilities offered by the city, education.
- **QUALITY OF LIFE** (QLI) – trust in other residents, satisfaction with life in the city, assessment of the city as a place to live.
- **SOCIAL COHESION INDICATORS** (SCI) – health care, safety, friendliness towards immigrants, minorities, LGBT communities, non-material help.
- **TRANSPORT** (TRN) – diverse evaluation of urban transport.

Based on the Eurostat database, the following set of indicators is proposed in Table 3.

Table 3.
Indicators for the assessment of cities

ID	Questions with answer variants and weights
ECO_01	In this city, it is easy to find a good job: strongly agree; somewhat agree; somewhat disagree; strongly disagree; don't know / no answer: [2, 1, -1, -2, 0]
ECO_02	In this city, it is easy to find good housing at a reasonable price: strongly agree; somewhat agree; somewhat disagree; strongly disagree; don't know / no answer: [2, 1, -1, -2, 0]
ECO_03	The financial situation of your household: very satisfied; fairly satisfied; not very satisfied; not at all satisfied; don't know / no answer: [2, 1, -1, -2, 0]
ECO_04	If you needed material help (e.g. money, a loan or an object), you could receive it from relatives, friends, neighbours or other persons you know: yes; no; don't know / no answer / refuses: [1, 0, 0]
ENV_01	Green spaces such as public parks or gardens: very satisfied; rather satisfied; rather unsatisfied; not at all satisfied; don't know / no answer: [2, 1, -1, -2, 0]
ENV_02	The quality of the air in the city: very satisfied; rather satisfied; rather unsatisfied; not at all satisfied; don't know / no answer: [2, 1, -1, -2, 0]
ENV_03	The noise level in the city: very satisfied; rather satisfied; rather unsatisfied; not at all satisfied; don't know / no answer: [2, 1, -1, -2, 0]
GOV_01	I am satisfied with the amount of time it takes to get a request solved by my local public administration: strongly agree; somewhat agree; somewhat disagree; strongly disagree; don't know / no answer / refuses: [2, 1, -1, -2, 0]
GOV_02	The procedures used by my local public administration are straightforward and easy to understand: strongly agree, somewhat agree; somewhat disagree, strongly disagree; don't know / no answer / refuses: [2, 1, -1, -2, 0]
GOV_03	Information and services of my local public administration can be easily accessed online: strongly agree; somewhat agree; somewhat disagree; strongly disagree; don't know / no answer / refuses: [2, 1, -1, -2, 0]
GOV_04	There is corruption in my local public administration: strongly agree; somewhat agree; somewhat disagree; strongly disagree; don't know / no answer / refuses: [-2, -1, 1, 2, 0]
HUC_01	Sports facilities such as sports fields and indoor sports halls in the city: very satisfied; rather satisfied; rather unsatisfied; not at all satisfied; don't know / no answer: [2, 1, -1, -2, 0]
HUC_02	Cultural facilities such as concert halls, theatres, museums and libraries in the city: very satisfied; rather satisfied; rather unsatisfied; not at all satisfied; don't know / no answer: [2, 1, -1, -2, 0]
HUC_03	Schools and other educational facilities: very satisfied; rather satisfied; rather unsatisfied; very unsatisfied; don't know / no answer / refuses: [2, 1, -1, -2, 0]
QLI_01	Generally speaking, most people in this city can be trusted: strongly agree, somewhat agree, somewhat disagree, strongly disagree; don't know / no answer: [2, 1, -1, -2, 0]
QLI_02	Most people in my neighbourhood can be trusted: strongly agree, somewhat agree; somewhat disagree, strongly disagree; don't know / no answer: [2, 1, -1, -2, 0]
QLI_03	I'm satisfied to live in this city: strongly agree; somewhat agree; somewhat disagree; strongly disagree; don't know / no answer: [2, 1, -1, -2, 0]
QLI_04	The neighbourhood where you live: very satisfied; fairly satisfied; not very satisfied; not at all satisfied; don't know / no answer: [2, 1, -1, -2, 0]
QLI_05	For people in general: a good place to live; not a good place to live; don’t know/no answer/refuses: [2, 1, 0]
SCI_01	Health care services, doctors and hospitals: very satisfied; rather satisfied; rather unsatisfied; very unsatisfied; don't know / no answer / refuses: [2, 1, -1, -2, 0]
SCI_02	I feel safe walking alone at night in my city: strongly agree; somewhat agree; somewhat disagree; strongly disagree; don't know / no answer / refuses: [2, 1, -1, -2, 0]
SCI_03	I feel safe walking alone at night in my neighbourhood: strongly agree; somewhat agree; somewhat disagree; strongly disagree; don't know / no answer / refuses: [2, 1, -1, -2, 0]
SCI_03	For racial and ethnic minorities: a good place to live; not a good place to live; don’t know/no answer/refuses: [-1, -2, 0]
SCI_04	For gay or lesbian people: a good place to live; not a good place to live; don’t know/no answer/refuses: [2, 1, 0]
SCI_05	For immigrants from other countries: a good place to live; not a good place to live; don’t know/no answer/refuses: [-1, -2, 0]
SCI_07	For young families with children: a good place to live; not a good place to live; don’t know/no answer/refuses: [2, -2, 0]

Cont. table 3.

SCI_08	For elderly people: a good place to live; not a good place to live; don't know/no answer/refuses: [2, -2, 0]
SCI_06	Confidence in the local police force: yes; no; don't know / no answer / refuses: [1, 0, 0]
SCI_07	Money or property stolen from you or another household member in your city the last 12 months: yes; no; don't know / no answer / refuses: [0, 1, 0]
SCI_08	Being assaulted or mugged in your city the last 12 months: yes; no; don't know / no answer / refuses: [0, 1, 0]
SCI_09	If you needed non material help (e.g. somebody to talk to, help with doing something or collecting something), you could receive it from relatives, friends, neighbours or other persons you know: yes; no; don't know / no answer / refuses: [1, 0, 0]
TRP_01	Public transport in the city, for example, bus, tram or metro: very satisfied; rather satisfied; rather unsatisfied; not at all satisfied; don't know / no answer: [2, 1, -1, -2, 0]
TRP_02	Means of transport most often used : car; motorcycle; bicycle; foot; train; **urban public transport**; other; do not commute; don't know / no answer / refuses : [0,0,0,0,0,**1**,0,0,0]
TRP_03	Public transport affordable: strongly agree; somewhat agree; somewhat disagree; strongly disagree; don't know / no answer / refuses: [2, 1, -1, -2, 0]
TRP_04	Public transport safe: strongly agree; somewhat agree; somewhat disagree; strongly disagree; don't know / no answer / refuses: [2, 1, -1, -2, 0]
TRP_05	Public transport easy to get: strongly agree; somewhat agree; somewhat disagree; strongly disagree; don't know / no answer / refuses: [2, 1, -1, -2, 0]

Source: own elaboration.

3. Methods

The answers to the questions are predominantly on a 5-point Likert scale. Each question is accompanied by the weights applied to each answer. The database shows the percentage of citizens choosing individual categories. Weighted answers to each question were determined, thus obtaining the indicator's value. The scales have been selected so that a larger value of the indicator shows the greater importance of the indicator.

Then, the obtained values were normalised using a formula that considered the worst and best assessments in each of the studied periods.

The formula used is min-max normalisation:

$$score(x_i) = (100 - 50)\frac{x_i - \min\limits_{k\in\{i,j\}}(x_k)}{\max\limits_{k\in\{i,j\}}(x_k) - \min\limits_{k\in\{i,j\}}(x_k)} + 50 \quad (1)$$

where:

i – index for 2019 data,

j – indexes for 2023 data.

After normalisation, the average value of the indicators was determined for each criterion, and the final ranking was obtained as the sum of the city's ranking for each requirement.

The final score was determined by calculating the sum of all the indicator's weighted average scores. Below is a detailed description of each factor within the study and the source used.

4. Results and discussion

After the calculations have been carried out following the proposed procedure. The following final results were obtained, showing the ranks for each criterion and the city's final ranking (Figure 1, Table 4, Table 5)

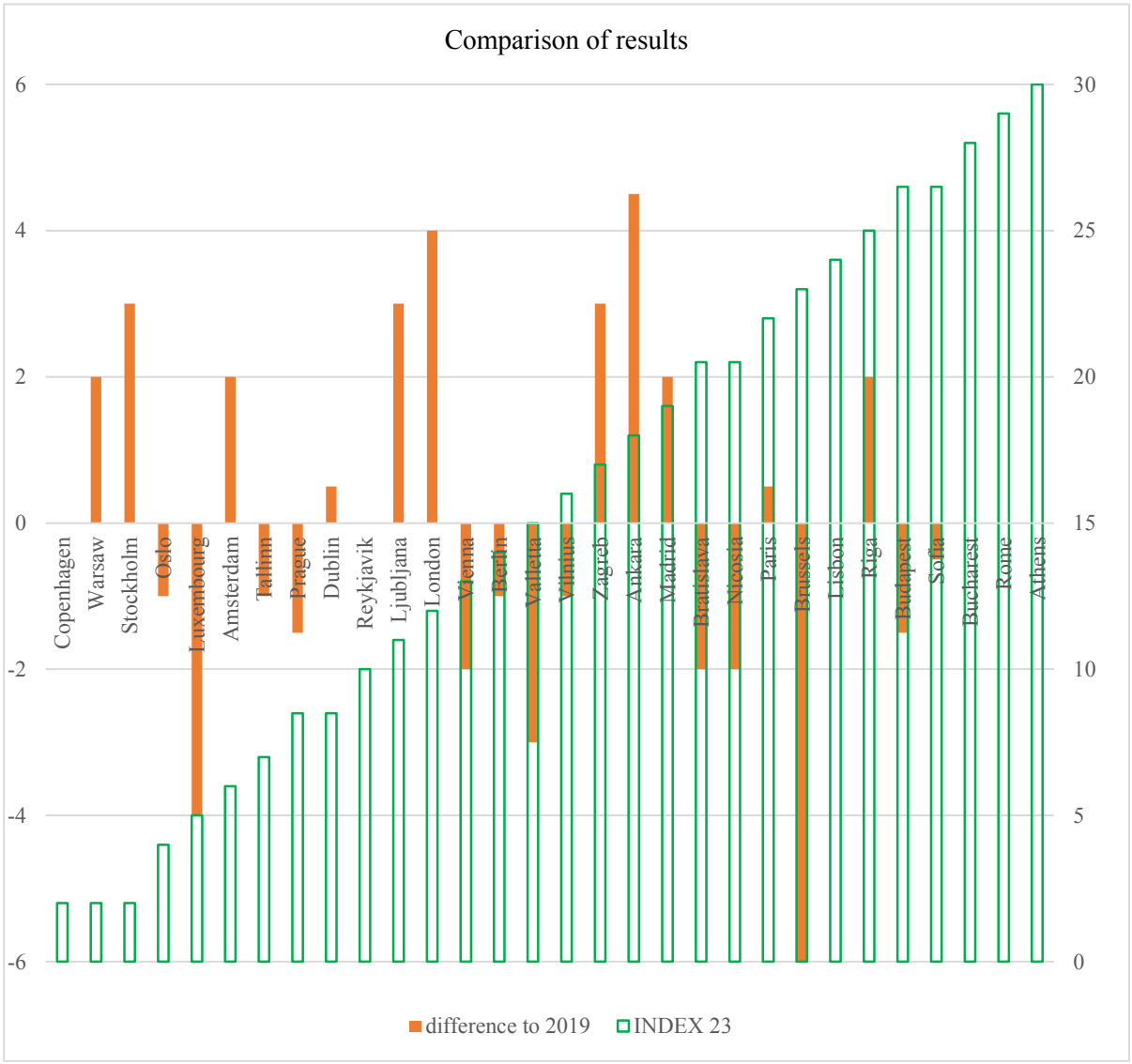

Figure 1. Comparison of INDEX 23 results and difference compared to 2019 results.

Source: own research.

Table 4.
Indicators for the assessment of cities – year 2019

Capitol	ECO	ENV	GOV	HUC	QLI	SCI	TRP	INDEX 19
Amsterdam	12	13	8	4	12	7	14	8
Ankara	24	15	3	27	21	26	24	22,5
Athens	30	30	28	30	30	30	27	30
Berlin	10	11	25	17	11	10	11	13
Bratislava	13	20	18	22	20	18	12	18,5
Brussels	26	19	6	14	18	19	18	17
Bucharest	8	29	23	29	27	24	21	28
Budapest	27	22	10	23	25	25	15	25
Copenhagen	3	8	2	9	1	4	9	2
Dublin	15	1	7	6	6	20	23	9
Valletta	7	28	4	24	8	3	17	12
Nicosia	20	18	9	15	16	16	29	18,5
Lisbon	29	21	27	18	15	8	26	24
Ljubljana	18	7	17	3	23	17	20	14
London	19	14	13	16	19	21	13	16
Luxembourg	16	2	1	2	5	1	2	1
Madrid	28	24	20	25	13	13	8	21
Oslo	2	3	19	8	2	2	5	3
Paris	23	25	11	12	24	23	22	22,5
Prague	1	16	21	5	14	9	1	7
Reykjavik	17	4	22	1	3	5	28	10
Riga	22	12	26	20	26	28	25	27
Rome	25	27	30	28	29	27	30	29
Sofia	6	26	24	26	28	29	16	26
Stockholm	9	6	15	10	4	6	7	5
Tallinn	5	10	14	11	9	12	4	6
Vienna	4	9	12	19	10	15	19	11
Vilnius	11	23	16	13	22	22	6	15
Warsaw	14	5	5	7	7	11	3	4
Zagreb	21	17	29	21	17	14	10	20

Source: Own research.

The most significant drop in the ranking is in Brussels; it fell by six places, then a substantial drop by four places was recorded by Luxembourg, which lost the first place in 2019. Surprisingly, Ankara, London, and Stockholm are the capitals that have gained the most. London, with the beginnings of the Brexit crisis; and Stockholm, with a completely different policy of restrictions against the COVID pandemic, have gained the most in the eyes of their citizens.

Table 5.
Indicators for the assessment of cities – year 2023

Capitol	ECO	ENV	GOV	HUC	QLI	SCI	TRP	INDEX 23
Amsterdam	12	13	8	4	10	4	14	6
Ankara	20	16	4	25	17	25	19	18
Athens	29	30	28	30	30	30	27	30
Berlin	15	15	26	17	9	10	11	14
Bratislava	9	21	21	23	20	19	20	20,5
Brussels	26	19	5	18	23	24	23	23
Bucharest	14	29	27	29	28	23	24	28
Budapest	27	23	12	22	25	26	22	26,5
Copenhagen	4	8	1	10	2	5	12	2
Dublin	17	1	6	5	6	15	21	8,5
Valletta	11	28	7	24	12	7	17	15
Nicosia	21	18	10	16	22	17	29	20,5
Lisbon	28	22	24	21	18	8	26	24
Ljubljana	13	7	15	3	14	16	16	11
London	19	11	9	13	11	12	10	12
Luxembourg	23	3	2	7	7	6	4	5
Madrid	24	25	17	28	15	14	9	19
Oslo	2	5	20	8	1	1	6	4
Paris	30	24	11	14	24	18	15	22
Prague	1	17	19	2	19	11	2	8,5
Reykjavik	8	6	22	1	4	3	28	10
Riga	22	12	23	19	26	29	25	25
Rome	25	26	30	26	29	27	30	29
Sofia	10	27	25	27	27	28	13	26,5
Stockholm	5	4	14	11	3	2	3	2
Tallinn	6	9	13	9	8	20	5	7
Vienna	3	10	16	20	13	21	18	13
Vilnius	7	20	18	12	21	22	8	16
Warsaw	16	2	3	6	5	9	1	2
Zagreb	18	14	29	15	16	13	7	17

Source: Own research.

The results obtained for the four best capitals in the ranking and the two worst were compared on radar charts (Figure 2).

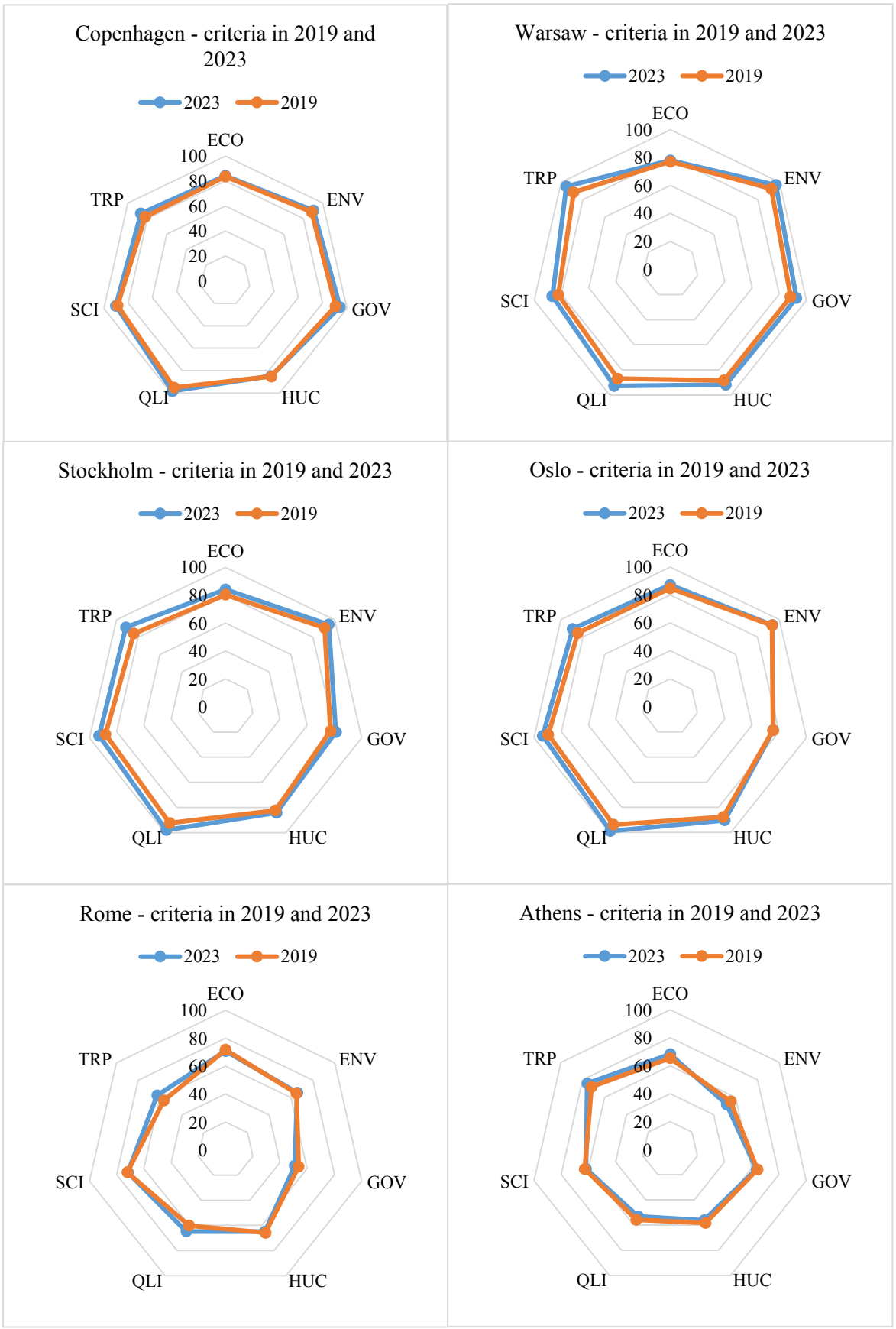

Figure 2. Radar chart for four of the best capitols and two of the worst.

Source: own research.

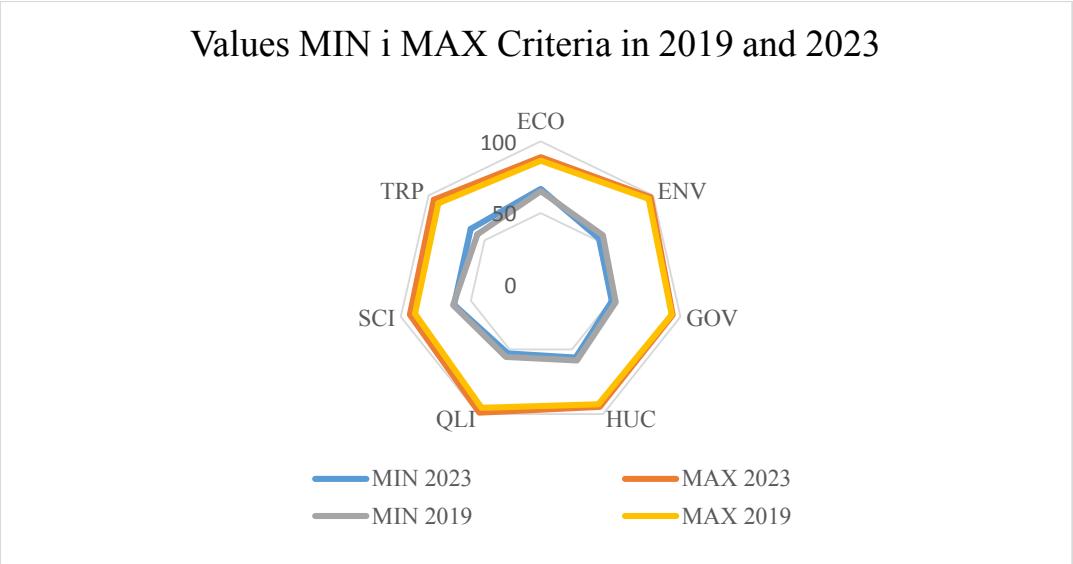

Figure 3. Radar chart – min and max values in the year for the proposed criteria.

Source: own research.

Comparing the maximum values for the obtained values of the criterion before the rank is determined, no significant differences in the values concerning the years can be seen. However, these values deviate from the assumed minimum and maximum values for individual criteria. The most significant deviations from the values for max 100 and min 50 are for the economic criterion. This is influenced by two questions, ECO_1 and ECO_2, which are negatively correlated. The more we earn, the prices of apartments rise, and it is more difficult to buy an apartment reasonably priced.

Table 6

Kruskal-Wallis rank sum test result

YEAR	STATISTIC	P.VALUE	PARAMETER
2019	12,91	0,04	6
2023	6,23	0,40	6

Source: Own research.

Table 7

Pairwise comparisons using Wilcoxon rank sum exact test p-value

	ECO	ENV	GOV	HUC	QLI	SCI
ENV	0,31	-	-	-	-	-
GOV	0,59	0,59	-	-	-	-
HUC	0,69	0,59	0,96	-	-	-
QLI	0,27	0,93	0,59	0,55	-	-
SCI	0,07	0,93	0,55	0,55	0,84	-
TRP	0,00	0,84	0,27	0,29	0,55	0,59

p-value adjustment method: BH

Source: Own research.

Table 8
Kruskal-Wallis rank sum test result

indic	STATISTIC	P.VALUE	PARAMETER
ECO	0,25	0,62	1
ENV	0,25	0,62	1
GOV	0,52	0,47	1
HUC	0,12	0,73	1
QLI	1,51	0,22	1
SCI	1,77	0,18	1
TRP	8,66	0,00	1

Source: own research.

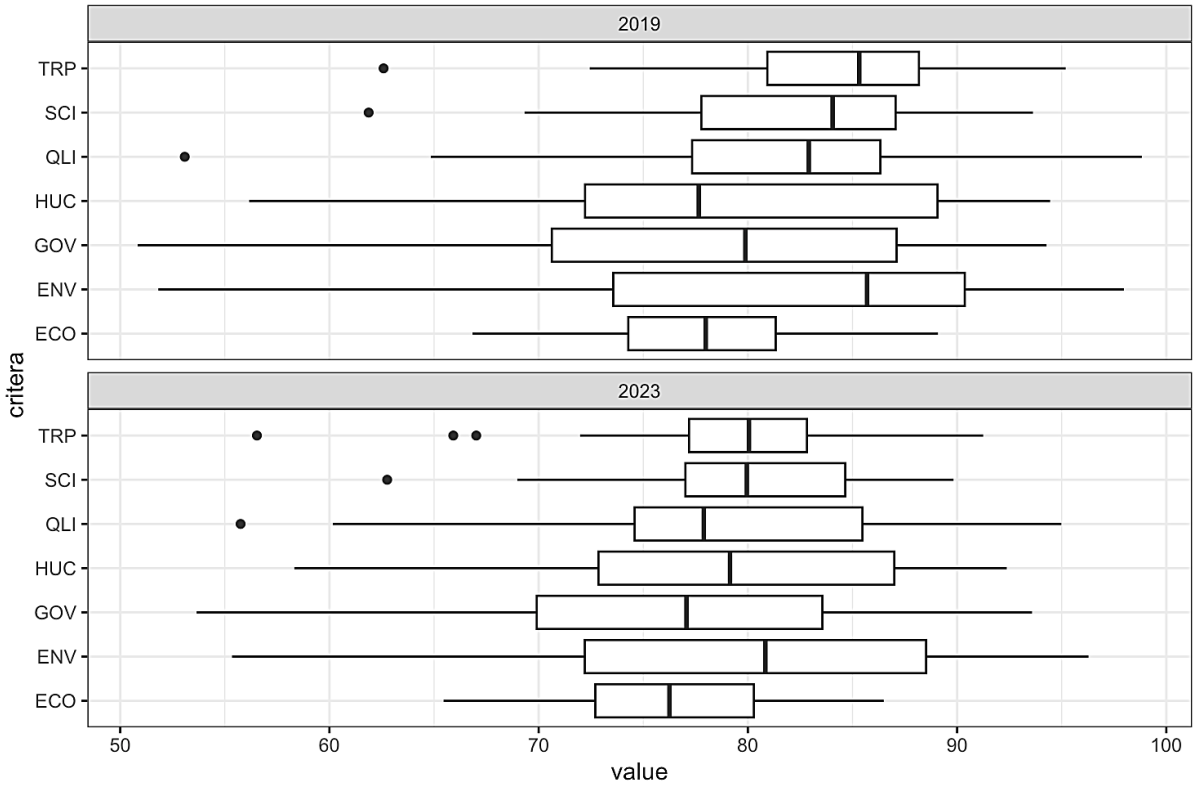

Figure 4. Boxplots for criteria.

Source: own research.

A boxplot has been created for each of the criteria. Boxplot charts show how the distribution of values for individual years is shaped. Analyzing the median values for individual criteria, it can be concluded that, in general, the city ratings in individual categories have decreased.

The data analysis based on the Kruskal-Wallis test shows that the individual categories did not differ in 2013. However, in 2019, there is at least one that is significantly different from the others.

5. Conclusion

As you can see, the most significant drop in the ranking is in Brussels; it fell by six places, then a substantial drop by four places was recorded by Luxembourg, which lost the first place in 2019. Surprisingly, Ankara, London, and Stockholm are the capitals that have gained the most. London, with the beginnings of the Brexit crisis; and Stockholm, with a completely different policy of restrictions against the COVID pandemic, have gained the most in the eyes of their citizens.

The lack of COVID data directly related to cities did not allow to examine the broader associations of the assessment with the pandemic

References

1. Akande, A., Cabral, P., Gomes, P., Casteleyn, S. (2019). The Lisbon ranking for smart, sustainable cities in Europe. *Sustainable Cities and Society, 44*, pp. 475-487. Retrieved from: https://doi.org/10.1016/j.scs.2018.10.009.
2. Berger, R. (2019). *Smart city strategy index: Vienna and London leading in worldwide ranking.* Retrieved from: https://www.rolandberger.com/publications/publication_pdf/roland_berger_smart_city_breakaway_1.pdf.
3. Cohen, B. (2015). *The 3 Generations of Smart Cities Inside the Development of the Technology Driven City*. Retrieved from: https://www.fastcompany.com/3047795/the-3-generations-of-smart-cities.
4. Giffinger, R., Gudrun, H. (2010). Smart Cities Ranking: An effective instrument for the positioning of the cities? *ACE: Architecture, City and Environment, 4(12)*, pp. 7-26. Retrieved from: https://doi.org/10.5821/ace.v4i12.2483.
5. Jonek-Kowalska, I. (ed.) (2019). *Wyzwania i uwarunkowania zarządzania inteligentnymi miastami*. Gliwice: Wydawnictwo Politechniki Śląskiej. Retrieved from: https://www.researchgate.net/publication/340298206.
6. Kaiser, Z.R.M.A. (2024). Smart governance for smart cities and nations. *Journal of Economy and Technology, 2*, *216234*. Retrieved from: https://doi.org/10.1016/j.ject.2024.07.003.
7. Kinelski, G. (2022). Smart City 4.0 as a set of social synergies. *Polish Journal of Management Studies, 26(1)*, pp. 92-106. Retrieved from: https://doi.org/10. 17512/pjms.2022.26.1.06

8. Kozak, A. (2022). The Role of Smart Cities during the COVID-19 Pandemic – the Example of New York City. *Biblioteka Regionalisty, 22*, pp. 23-33. Retrieved from: https://doi.org/10.15611/br.2022.1.03.
9. Kuzior, A. (2024). Smart City Conceptual Framework in the Context of Achieving Sustainable Development Goals. *Management Systems in Production Engineering, 32(2)*, pp. 156-161. Retrieved from: https://doi.org/10.2478/mspe-2024-0015.
10. Lai, C.M.T., Cole, A. (2023). Measuring progress of smart cities: Indexing the smart city indices. *Urban Governance, 3(1)*, pp. 45-57. Retrieved from: https://doi.org/10.1016/j.ugj.2022.11.004.
11. Marchlewska-Patyk, K. (2023). Ewolucja koncepcji smart city jako wyznacznik rozwoju współczesnych miast-polska perspektywa. *Akademia Zarządzania, 7(1)*. Retrieved from: https://doi.org/10.24427/az-2023-0009
12. Pangsy-Kania, S., Kania, K. (2024). Key Dimensions in Smart Cities' Rankings - Towards Enhancing the Quality of Life for Smart Cities' Inhabitants. *Ekonomia i Prawo, 23(3)*, pp. 493-518. Retrieved from: https://doi.org/10.12775/EiP.2024.025.
13. *Report on the quality of life in European cities* (2023). Retrieved from: https://doi.org/10.2776/182815.
14. Svítek, M., Skobelev, P., Kozhevnikov, S. (2020). *Smart City 5.0 as an Urban Ecosystem of Smart Services* (pp. 426-438). Retrieved from: https://doi.org/10.1007/978-3-030-27477-1_33.
15. Toh, C.K. (2022). Smart city indexes, criteria, indicators and rankings: An in-depth investigation and analysis. *IET Smart Cities, 4(3)*, pp. 211-228. Retrieved from: https://doi.org/10.1049/smc2.12036.
16. Vanli, T. (2024). Ranking of Global Smart Cities Using Dynamic Factor Analysis. *Social Indicators Research, 171(2)*, pp. 405-437. Retrieved from: https://doi.org/10.1007/s11205-023-03259-7.
17. Warszawski, U., Mikucki, J. (2021) Koncepcja smart city a COVID-19. Wykorzystanie nowych mediów w obliczu pandemii. *Media Biznes Kultura, Vol. 2, Iss. 11*, pp. 75-95.