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THE CONCEPT OF SUSTAINABLE DEVELOPMENT AND ITS APPLICATION WITHIN V4 CAPITALS

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Abstract: *The development and perception of the world in the 21st century create many opportunities and challenges that must be overcome, and goals fulfilled to ensure continuous growth with a positive outlook on the ecological, technological, demographic, or socio-economic aspects of the whole. The main goal is to identify the current state of application of the sustainable development methodology across the capitals of the V4 with the subsequent identification of impacts on the environmental, economic, technological, or social areas. To achieve the primary goal of the contribution, we will have to apply the concept of sustainable development first to the V4 countries and later to the capital cities of the V4 countries, by which we will stimulate the necessary monitored variables. At the same time, we will use broad secondary research to identify the required variables, which will be processed by several general and logical methods. At the same time, we will compare the results between the studied subjects. When researching in capital cities, we noted a strong positive interaction of Hungary about the ecological aspect. Still, socio-economic factors were in the larger domain of the Czech Republic. Poland was the best, but it changed clearly when we compared the capital cities of V4 countries. Bratislava was the best capital city in fulfilling the SDG concept; the worst was Budapest. Bratislava was the best regarding safety and social characteristics, while Budapest had negative prospects in 5 of the 15 SDG goals examined. On the contrary, Bratislava and Prague had favourable chances of meeting the goals in 7 investigated and only in 2. This indicates the differences in reviewing this issue from a macro and micro perspective. For that reason, this metric is also critical in monitoring the development of individual parts of the world. At the same time, it also became one of the conditions for joining the European Union.*

Keywords: Visegrad Group; Sustainable Development; Circular economy

1 INTRODUCTION

We characterize sustainable development as a complex, strategic, targeted multidimensional concept to improve living conditions. The concept is one of the most critical and cited development goals within the European Union. It characterizes these goals within its Strategy 2020 program. From a theoretical point of view, the concept is defined in three interrelated pillars – economic, social, and environmental [4]. Within the scope of the economic pillar, effective and optimized economic growth is important from the point of view of the growth of the capital itself. The social pillar aims to continuously reduce differences in social conditions and increase citizens' qualifications. The last environmental pillar includes the activities of the economic and social pillar with an emphasis on the effective use of natural resources. Together they create a necessary whole, which has become a symbol of world development in the 21st century.

The trend of sustainable development has its preconditions in the development of the community itself. Due to the constant development of the community and the consumer itself, such conditions and reforms must be created and adopted that will simultaneously develop the consumer and the community itself in the established expectations. Understanding the perception and expectations of the consumer has therefore become the basis for the very development of the community from the point of view of socioeconomic assumptions, demographic, cultural or ecological growth as well as the application of emerging trends in several areas of social life. For this reason, such growth conditions must be set to satisfy the consumer's expectations and achievable in a reasonable set period. The consumer and his behaviour are the basis for applying the concept of sustainable development practices in all areas. With the understanding of the consumer and his consumer behaviour, a basis is created for the subsequent development of the community itself, considering all development activities.

Within the capital cities, the urban economy is fully utilized. Using the knowledge of the urban economy is the basis of building a given territory for a specific purpose. That is why many projects deal with the economic side and the advantage of building or using the selected unit as possible advantageous investment capital. The influence of the urban economy is also manifested in applying sustainable development. The given activity defines the permissible use of natural resources to the extent that we can compensate for it with the help of humans [5].

The creation of sufficient conditions for the development of cities using the principles of the urban economy can also be perceived with the help of agglomeration savings. We define *agglomeration savings* as: "*advantages resulting from the association and spatial concentration of activity in cities, together with the availability of natural resources and the use of strategic location*" [5]. Along with this, cities must acquire strategic comparative advantages to ensure their continued development and growth. Real estate as strategic elements of the development of communities, communities, and the development itself must create

together a continuous process of logical applying attributes. Therefore, in the housing area's development conditions, we must appeal to urban studies and create a meaningful spatial plan to ensure the given territory's qualitative growth. When these conditions are met, the effect of spatial sociology and thus regional development will begin to emerge. The various authors [3] characterize the very essence of the study of spatial sociology as: "a multidimensional summary of specific social and non-social components that are part of it and together form part of the life and existential situation of a society living in a certain territory." The content of changes in the socio-spatial situation is represented by changes in society's spatial distribution and character. It is a summary of changes in the character of settlements and their communities, the residential, settlement and social environment, the social structure, social and spatial mobility, social relations and generally the way of life. The development of this situation is significantly influenced and marked by several factors. One of them is, in addition to the spatial factor, the time factor" [3].

Importance of urbanism is responsible for solving the issue of territorial development and settlement at all levels about environmental protection. In the local conditions, a sustainable form of urbanism is beginning to be applied. In our conditions, sustainable urbanism is associated with the circular economy and, therefore, the most efficient use of raw materials, the possibility of their reuse, and the subsequent creation of systematic urban units. Municipal or urban entities have a high degree of decentralization to natural resources while trying to achieve high self-sufficiency in the given area. For this, an urban technological system connected to the most significant urban and civil systems with a low burden on the environment is being created [2].

The issue of sustainable development is a very current issue, which, with its multidisciplinary, affects every spectrum, be it the country's politics, the life of the people in it, and scientific research. The article's main goal is, therefore, to characterise the current state of application of the sustainable development methodology across the capital cities of the V4 with subsequent identification of the impacts on the environmental, economic, technological, or social sphere. From the theoretical and practical fulfilment of this concept, worldwide countries, but mainly the countries of the European Union, are trying to achieve the results set out in the Paris Climate Agreement from 2015 with effect from 2016. These results should be partially met, at least until 2030, when the effort is to transfer all economic areas from the economy's linear concept to the economy's circular system. Therefore, it is indispensable to research this topic in the micro-area, which subsequently shapes the macro-area itself.

Sustainable development is firmly anchored in the European Treaties and has been at the heart of European policy for a long time. The 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs), adopted by the UN General Assembly in September 2015, have given a new impetus to global efforts for achieving sustainable development. The EU is fully committed to playing an active role in helping to maximise progress towards the Sustainable Development Goals.

The indicator set comprises around 100 indicators and is structured along the 17 SDGs. For each SDG, it focuses on aspects that are relevant from an EU perspective. The monitoring report provides a statistical presentation of trends relating to the SDGs in the EU over the past five years ('short-term') and, when sufficient data are available, over the past 15 years ('long-term') [1].

2 METHODOLOGY

The primary goal is to identify the current state of application of the sustainable development methodology across the capitals of the V4 with the subsequent identification of impacts on the environmental, economic, technological, or social areas.

To achieve the goal of the contribution, it was necessary to use various background materials, consisting primarily of the study of professional domestic and foreign literature, as well as the understanding of data and statistics from official sources of the UN and Eurostat. The article itself contains ten figures and five tables.

We summarized and logically organized the acquired knowledge using the following methods. Selected methods using the principles of logical thinking such as abstraction, comparison, analysis, and synthesis were also used in the paper. We used the abstraction method to single out the essential facts to process the knowledge base, consisting of domestic and foreign sources. In the article, we use the scientific method comparison. Individual data were evaluated together with the respective countries. We used mathematical and statistical methods to process results from statistical portals and final reports. At the same time, we compared and evaluated the given results. To achieve the primary goal, we divided the studied area into macro (V4 countries) and micro (capital cities of V4 countries) to identify the investigated parameters.

Currently, the most given metric is used in our space within the framework of the 2030 Agenda from the UN workshop, when the states of the European Union are trying to fulfil the studied goals in the shortest possible time and to the greatest extent, which are divided into 17 separate categories and 169 goals. The design of these goals and their subsequent achievement will help the full circularity of economies, with an emphasis on digitalization, innovation, the protection of human lives and animals, and the background of reducing the creation of negative climate impact. At the same time, we can identify these areas more closely in figure 1.

Figure 1 Sustainable Development Goals by UN

Source: Author used figure from https://www.sustainabledevelopmentindex.or/, 2022

At the same time, the most prominent communities such as the UN, the World Bank, and the OECD, but also groups such as the European Union, have created a methodology for individual agents, according to which they evaluate the results achieved in the monitored time, which are adapted based on geographical location, demographic level, economic situation, technological and investment fund, social rights and justice, but also the state of the environment in the given region.

Nevertheless, a unified methodology was also created for all participating countries for a better specification of the results and their comparison between the regions. Based on this, we can compare the results between the investigated areas, which we identified in more detail in figures 2 and 3.

Figure 2 Comparison of SDG fulfillment world regions in 2021

Source: Author used figure from https://dashboards.sdgindex.org/chapters/part-2-the-sdg-index-and-dashboards, 2022

From a regional point of view, we notice a different influence within individual geographical divisions and thus often based on cultural and demographic habits. Areas in which developing countries are located have better results in the spheres of the industry within the framework of meeting the goals of the SDGs. In contrast, developed countries have better conditions for the social enjoyment of the inhabitants and the rights associated with it. We can also see that East and South Asia have already achieved SDG 12, the Oceania region has achieved SDG 13, and Sub-Saharan Africa has achieved SDG 12. However, other regions often have positive trends, but stagnant trends in meeting these goals are the most prevalent.

We note a significant negative trend in the fulfilment of SDGs 2-3, 5-8, 10-11 and 14-17 in several regions examined. The results also indicate a phenomenon where, according to the logical assumption, countries with higher incomes achieve better results than developing countries. It is clearly identified within SDGs 1, 4, 6, and 9. However, on the contrary, the countries we describe as developing achieved better results within SDG 12, 13 and thus, factors focused on the production process and the related ecological footprint. This can also explain the strong connection between these countries, which are often linked to manufacturing and heavy industry.

On the contrary, we can precisely perceive these differences when specifying the examined V4 countries graphically shown in figure 3. Slovakia achieved only SDG 10, while the others have an average positive trend of achieving results. The Czech Republic achieved outstanding results within SDGs 1, 8, and 10 with a positive trend towards achieving the goal, while within SDG 11, we also note a positive trend which has not yet been achieved. Conversely, Hungary has not yet achieved any set goals but is achieving positive results within SDGs 1 and 11. Subsequently, Poland has already achieved SDGs 1 and 10. At the same time, it is achieving a positive trend within SDGs 6 and 11.

Within regionalism, the best results are recorded in the countries belonging to the Northern Europe geographical group, where they achieved most of the SDGs, such as SDGs 7, 9, 10, 11 and 17. We also have outstanding results within the EFTA community, where these countries have already achieved positive results within SDGs 1, 7, 9, and 11 and have a positive trend within SDGs 8 and 10. Central and Eastern Europe, including the V4 countries, mostly achieved positive results within SDGs 1, 6 and 11. The overall negative is that European countries achieved negative results within SDG 12-15. We can see more results in figure 3.

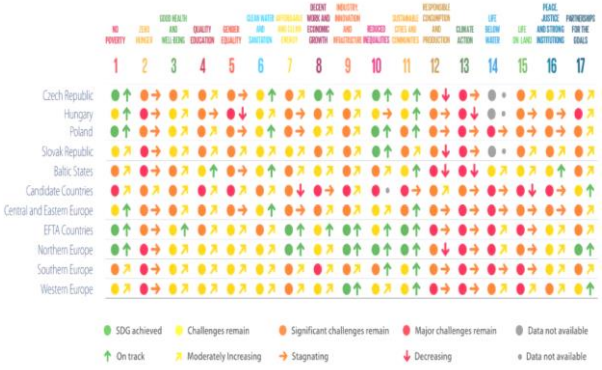


Figure 3 Comparison of SDG fulfilment in Europe in 2021

Source: Author used figure from https://dashboards.sdgindex.org/chapters/part-2-the-sdg-index-and-dashboards, 2022

To better understand the investigated entities, we have summarized them in table 1 with their geographical and overall results in the field of SDG. This will help us closely examine the SDG parameters in the mentioned countries and their capital cities.

Table 1 Geographic specifics of V4 countries and their capital cities with SDGs ranking

Indicator/Country	Slovakia	Czechia	Hungary	Poland
Area in km^2	49 035	78 866	93030	312 696
Population in mil.	5.459	10.7	9.75	37.95
Ranking	24	13	21	12
Capital City	Bratislava	Prague	Budapest	Warsaw
Area in km^2	367.6	496	525.2	517.2
Population	475503	1259079	1744665	1735442
Ranking	26	27	37	31

Source: Author used data from https://www.worldbank.org/en/home, 2022

We used research questions to help us achieve the article's primary goal to achieve goal.

The author focused on answering the following research questions (RQ):

- RQ1: How does fulfilment in selected aspects of the SDGs develop in defined areas affecting the environmental, economic, technological, or social areas within the V4 countries?
- RQ2: How does fulfilment in selected aspects of the SDGs develop in defined areas affecting the environmental, economic, technological, or social areas across the capital cities of the V4 countries?

The output of the article is the identification of the current state of SDG fulfilment from the macro view of the V4 countries and the micro view of specific V4 capitals. At the same time, the state of how the pandemic precisely affected the given parameter within the investigated areas is recorded.

All the acquired knowledge encouraged the author to a deeper analysis of the measurement of housing quality using a comparative, systematic analysis of scientific literature and statistical data to determine the interrelationships of the researched issues.

3. RESULTS AND DISCUSSION

First, to achieve the contribution's primary goal, we must answer the research questions chosen. For the macroeconomic perspective, we will first focus on the fulfilment of the goals from the perspective of the V4 countries and thus on the first research question.

RQ1: How does fulfilment in selected aspects of the SDGs develop in defined areas affecting the environmental, economic, technological, or social areas within the V4 countries?

To answer our research question, we will first have to define the perception of the success of fulfilling the concept of sustainable development from a long-term phenomenon. Therefore, in the following figure 4, we have shown the development of the SDG evaluation among the V4 countries from 2000 to 2022. It should be noted that the year 2022 is still ongoing; therefore, the year's figure is continuous until the first half of that year.

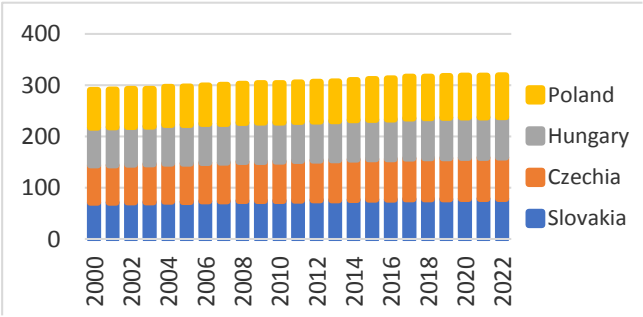


Figure 4 SDG Index Score from 2000 – 2022 across V4 states

Source: Author processed data from https://www.sustainabledevelopmentindex.org/, 2022

We noticed the most significant shift in the evaluation between two countries, namely Slovakia and Poland. Both countries have increased by 8 points during this monitored time, while Slovakia's initial rating in 2000 at level 71 has a current rating of 79 points. On the contrary, Poland moved from the level of 73 points in 2000 to the current value of 81 points in 2022. They are followed by the Czech Republic, which had a rating at the level in 2000 and an unchanged rating at 80 points since 2018. Hungary had the lowest increase, from the initial rating of 74 points to the current value of 79 points, which has remained unchanged since 2019.

At the same time, in the nearest adopted figure 5, performance in improving performance between individual regions of Europe is presented within the period 2010-2015 and subsequently within the period 2015-2019. Obtained points to the development between the regions, where we note gaps in sustainable development performance. From an overall perspective, countries that have long been among the world's most developed regions have the best performance. We include the countries of Northern Europe, with an average score on the SDG index of 81% in 2020. On the other hand, countries that have obtained candidate status for joining the European

Union record worse results, with an average score of over 55%, in 2020, which is due mainly to worse results in the socio-economic, but also in the legal field (SDG 1, SDG 3 to 9, 16).

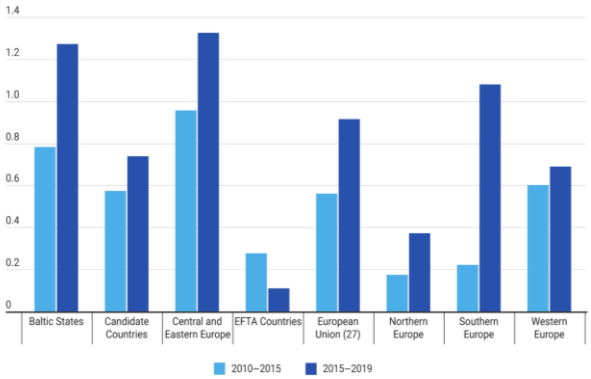


Figure 5 Comparison of individual regions of Europe in the evaluation of SDGs in the period 2010-2015 and 2015-2019

Source: Author used figure from https://eu-dashboards.sdgindex.org/chapters/part-1-performance-of-european-countries-against-the-sdgs, 2022

We took over to better understand the perception of the success of the V4 countries. We implemented the data for 2019, where we evaluated the countries' success in meeting sustainable development goals. This data represented a scale from 0 to 100, with 100 points representing the best score. See table 1 a is the best-performing country within the grouping of V4 countries. Poland's most prominent position is held (89.1), which confirms its position. It is followed by Slovakia (85.6), the Czech Republic (85.1) and Hungary (84.8). We can take a closer look at figure 6.

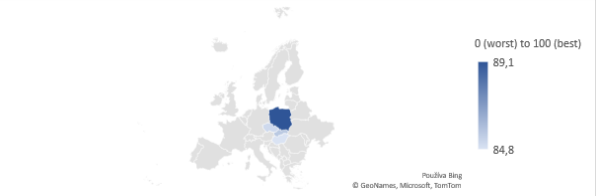


Figure 6 Statistical performance index across V4 countries

Source: Author processed data from https://dashboards.sdgindex.org/chapters/executive-summary, 2022

At the same time, it is necessary to note that most negative externalities come within the framework of international trade and, thus, international transactions in the production and supply chain. In total, this index consists of 14 indicators that are directly implemented within the SDGs. The index ranks countries on a scale from 0 to 100 points, with 100 points being the best score. The best is Oceania, the only one with a total number of points. As we can see in figure 7, the Czech Republic finished worst with a rating of 67.6 points, below the average of OECD countries at 70.7 points. Subsequently, other V4 countries, such as Slovakia (72) and Hungary (80.9), together with Poland (80.9), are also above the average.

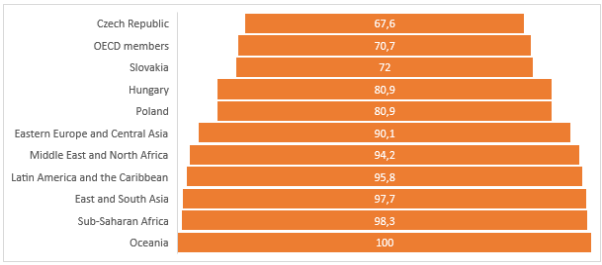


Figure 7 International spillover index across V4 countries, OECD members, and specifics regions

Source: Author processed data from https://dashboards.sdgindex.org/chapters/executive-summary, 2022

An essential attribute of comparing the examined V4 countries is the achievement of individual goals within the 17 SDGs. We made a graphic comparison within these countries on figure 8, where you can see the differences between the countries studied and the regional score in the given area. These differences confirm the performance for the year 2021 and, therefore, the current position of the countries, which we have expressed in Table 1. The best position is Poland in 12th place, followed by the Czech Republic in 13th place, Hungary in 21st place and Slovakia in 24th place for the year 2021. The weakest point of fulfilment is SDG 2 (Zero hunger), SDG 5 (Gender equality), SDG 7 (Affordable and clean energy), SDG 13 (Climate action), and SDG 14 (Life below water - this point is irrelevant for Slovakia, Hungary, the Czech Republic due to geographical inaccessibility to the sea) and the worst SDG 17 (Partnerships for the goals).

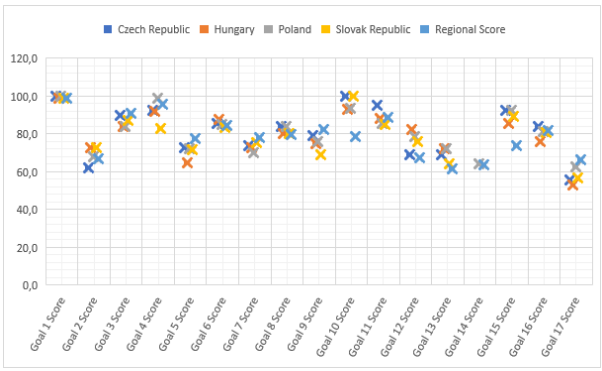


Figure 8 Results of achieving SDGs by V4 countries in 2021

Source: Author processed data from https://dashboards.sdgindex.org/rankings, 2022

The concept of sustainable development counts on direct integration within the internal policies of countries. In contrast, the adoption of the 17 goals of this concept depends on the application process of the following six activities: (1) education and skills, (2) health and well-being, (3) clean energy and industry, (4) sustainable land use, (5) sustainable cities and (6) digital technologies [7]. These activities are continuously monitored and updated with current needs. We also include the worsened epidemiological situation with the help of the Covid-19 virus. We will therefore take a closer look at the first three of the given activities, which we applied from the data for the year 2022 for the V4 countries. At the same time, we color-coded the given attributes according to the ambitiousness of meeting the given goals. We have the most significant achievement within the first goal when every country except Slovakia has Moderately ambitious or More ambitious goals. Slovakia does not have this activity in the Expenditure on research and development attribute when it invests only 0.8% of GDP in science and research.

On the other hand, in the second examined point, Poland gets an unflattering score, when 2/4 of the points meet Less ambitious, Hungary only one and, on the contrary, the Czech Republic 2/4 meets More ambitious. Slovakia is the only one that meets both Less ambitious and More ambitious. In the last examined point, except for Poland, they fulfil the studied metrics, while Poland lacks the fulfilment of the UN Climate Ambition Alliance Signatory. We can see more in table 2.

Table 2 Geographic specifics of V4 countries and their capital cities with SDGs ranking

Transformation	Indicator / Country	Slovakia	Czechia	Hungary	Poland
Transformation 1: Education, Gender and Inequality	Years of free education in the law	13	13	12	12
	Years of compulsory education in the law	10	9	10	9
	Commitment to Reducing Inequalities: Tax Progressivity & Protection of Labor Right	0.68	0.68	0.66	0.66
	Gender Equality in the Law	85	93.8	96.9	93.8
	Expenditure on research and development (from GDP %)	0.8	1.9	1.5	1.2
Transformation 2: Health, Well-being and Demography	UHC index of service coverage	77	78	73	74
	Catastrophic out-of-pocket health spending: Pop. spending 10%+ of household income on health	2.7	2.2	7.4	14.1
	Population coverage for health care	94.6	100	94	93.3
	Global Health Security Index: Pandemic Preparedness	54.4	52.8	54.4	55.7
Transformation 3: Energy Decarbonization and Sustainable Industry	UN Climate Ambition Alliance Signatory	✓	✓	✓	✕
	Policy- or NDC-based commitment to reach net-zero emissions by 2050	✓	✓	✓	✓
	1.5°C Paris-agreement-compatible climate action	Insufficient	Insufficient	Insufficient	Insufficient

More ambitious
Moderately ambitious
Less ambitious

Source: Author used data from https://dashboards.sdgindex.org/chapters/part-3-policy-efforts-and-commitments-for-the-sdgs, 2022

In another study of the V4 countries using the Sustainable Development Index (SDI) metric, the task is to measure the ecological efficiency of human development with the subsequent expansion of the generally recognized Human Development Index (HDI) metric. It expresses demographic variables such as life expectancy, income, or educational attainment while putting it proportionately to ecological activities such as CO2 per capita or the material footprint caused per capita (SDI, 2022). The success of the countries is related to the results and their closeness to point 1. Therefore, for a better understanding, we have shown in figure 9 the development of the final SDI rating for the V4 countries from 1990, when they were still part of the USSR, until 2019. In 2019, Hungary was the best, ranked 39th, Poland at 129th, the Czech Republic at 133, and Slovakia as high as 149.

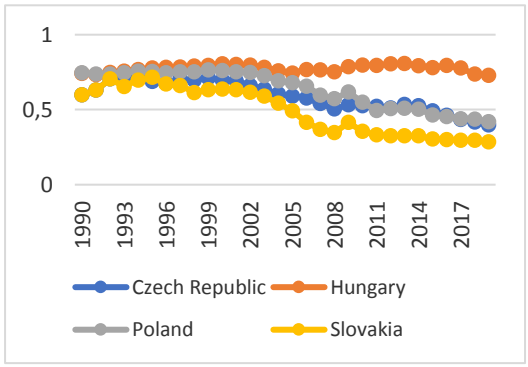


Figure 9 Sustainable Development Index from the 1990 –2019 across V4 countries

Source: Author processed data from https://www.sustainabledevelopmentindex.org/, 2022

We can see the effectiveness of SDI in the studied countries when relatively all of them started at a similar point. Only Hungary managed to maintain a growth trend from the long-term process, which reached its peak in 2013 when it reached a value of 0.808. In 2019, it was at the level of 0.728, which represents a decrease of 0.08 points. Poland peaked in 1999 when it reached the level of 0.765, while in 2019,

it was at the level of 0.42, representing a decrease of 0.345 points between the studied period. On the contrary, Slovakia peaked in 1995 at 0.716 and the Czech Republic in 1999 at 0.711 points. In 2019, there was a significant drop, especially in Slovakia, to the level of 0.285 (it represents a drop of 0.431 points), and in the Czech Republic, it was a drop of 0.312, which represented a level of 0.399 points in 2019.

We took it clearly in table 3, where we have all the investigated parameters graphically displayed for the period of the first year of investigation, 1990, then the years 2000, 2010 and the period 2015-2019. At the same time, each year, the value representing the best value was highlighted for better understanding.

Table 3 SDI Indicators from 1990, 2000, 2010 and 2015 – 2019 across V4 countries.

Indicator	Year/Country	Slovakia	Czechia	Hungary	Poland
SDI Score	2019	0.285	0.399	**0.728**	0.42
	2018	0.296	0.417	**0.737**	0.438
	2017	0.296	0.463	**0.777**	0.44
	2016	0.301	0.463	**0.794**	0.44
	2015	0.305	0.492	**0.779**	0.465
	2010	0.356	0.527	**0.798**	0.55
	2000	0.637	0.698	**0.805**	0.761
	1990	0.598	0.598	**0.741**	0.745
Life Expectancy (years)	2019	77.5	**78.7**	76	78.7
	2018	77.4	**78.9**	76.3	78.5
	2017	77.2	**79.1**	76.5	78.3
	2016	77	**79.2**	76.7	78.1
	2015	76.8	**79.4**	76.9	77.9
	2010	75.5	**77.6**	74.5	76.3
	2000	73.3	**74.9**	71.7	73.7
	1990	71.2	**71.9**	69.3	70.8
Expected Years of Schooling	2019	14.5	**16.8**	15.2	16.3
	2018	14.5	**16.8**	15.2	16.4
	2017	14.5	**16.8**	15.1	16.4
	2016	14.5	**16.9**	15.2	16.4
	2015	14.7	**16.9**	15.4	16.1
	2010	15	**16**	15.3	15.3
	2000	13.2	13.9	14.2	**14.7**
	1990	11.6	11.9	11.1	**12.2**
Mean Years of Schooling	2019	**12.7**	**12.7**	12	12.5
	2018	12.6	**12.7**	11.9	12.3
	2017	12.6	**12.7**	11.9	12.3
	2016	**12.6**	**12.6**	11.8	12.3
	2015	12.5	**12.7**	11.8	12.2
	2010	11.6	**12.4**	12.2	12.2
	2000	10.3	10.6	10.2	**11.1**
	1990	**10.8**	8.4	8.7	9.8
GNI pcap. const 2017$ PPP	2019	32113	**38109**	31329	31623
	2018	31403	**37294**	29840	30460
	2017	30267	**36124**	28344	28933
	2016	29477	**34562**	27503	27546
	2015	28733	**33720**	26289	26926
	2010	25509	**31046**	23369	23312
	2000	16670	**24568**	18362	16168
	1990	15225	**23867**	17910	11137
CO2 emissions per capita (tonnes)	2019	7.78	8.4	**5.04**	7.36
	2018	7.78	8.4	**5.04**	7.36
	2017	8.08	8.35	**4.19**	7.63
	2016	8.38	8.3	**3.95**	7.89
	2015	8.67	8.24	**4.61**	8.15
	2010	9.59	9.36	**5.17**	8.72
	2000	8.12	9.32	**4.87**	7.73
	1990	20.4	10.06	**6.04**	7.51
Material Footprint per capita (tonnes)	2019	35.33	23.09	**14.74**	24.67
	2018	35.33	23.09	**14.74**	24.67
	2017	35.33	23.09	**14.74**	24.67
	2016	34.88	22.81	**14.55**	24.15
	2015	34.42	22.52	**14.36**	23.63
	2010	31.31	22.04	**13.26**	21.9
	2000	21.86	16.22	**9.67**	13.06
	1990	13.12	13.12	**10.4**	9.02

Source: Author processed data from https://www.sustainabledevelopmentindex.org/, 2022

Based on the performed analysis, we note a high rate of success in the Czech Republic, which had the best results in up to 4 categories of the investigated parameter. However, these parameters were socio-economic. Hungary dominated the overall SDI score, which mainly led to the categories focused on the ecological side. It achieved very positive results when in the parameter CO2 emissions per capita (tonnes) it was 5.04, which was 2.34 points less than second Poland. Conversely, in the parameter Material Footprint per capita (tonnes), Slovakia had % more, representing 140% more, namely 20.59 more material footprint per capita (tonnes). Thus, we can acquire differences between the studied countries in the studied areas.

Conclusion of RQ1

The SDGs concept indicated the current state of development of the V4 countries to achieve a circular economy and comply with the Paris Climate Agreement. Currently, Poland has the best rating, while Slovakia has the worst rating. However, the V4 countries are among the best among the 193 UN countries in the researched evaluations. Precisely, the worst Slovakia was placed in 24th place. The first places are occupied by the countries of Northern Europe, while only 5 of the 30 ranks are outside European countries. Japan holds the highest place in 18th place. At the same time, the V4 countries already have several challenges met by 2030, while we note a neutral but also a positive effect of growth in other SDG parameters. In the SDI metric, we noted differences over time, which were also reflected in the investigated parameters. From an ecological point of view, we noted the dominance of Hungary, which recorded the lowest carbon footprint per inhabitant in the given parameters. In contrast, the highest level was recorded in Slovakia. From a technological point of view, Poland dominates the indicators, and from a socio-economic point of view, the Czech Republic dominates.

RQ2: How does fulfilment in selected aspects of the SDGs develop in defined areas affecting the environmental, economic, technological, or social areas across the capital cities of the V4 countries?

The cities themselves are specific entities from the point of view of their scope and overall effect on the entire country. They often represent local units that indicate the expected state of the SDGs in other parts of the given country. This situation also corresponds to the importance of investigating the given issue. To evaluate the performance of the capital cities of the V4 countries, we will first compare the status for 2019 from the view of 15 defined SDGs goals from the overall status of 17 SDGs within figure 10.

Specifically, we will not compare data for SDG 14 and SDG 17 due to their unavailability. The overall best location of the cities went to Bratislava, which was ranked 26th in the evaluation, followed by Prague in 27th place, Warsaw in 31st place and Budapest in 37th place. This rating is shown in table 1. Compared to the ranking of the countries, we have a significant shift, as the capital of Slovakia is ranked higher than the other V4 capitals, which was precisely the opposite in the case of the countries. This also applies to the position of the city of Budapest and Warsaw regarding the overall position of their countries in the ranking. This situation corresponds to figure 10, where we have these 15 SDGs listed and where the strengths and weaknesses of individual capitals can be seen. For a better understanding, we have detailed them in table 4.

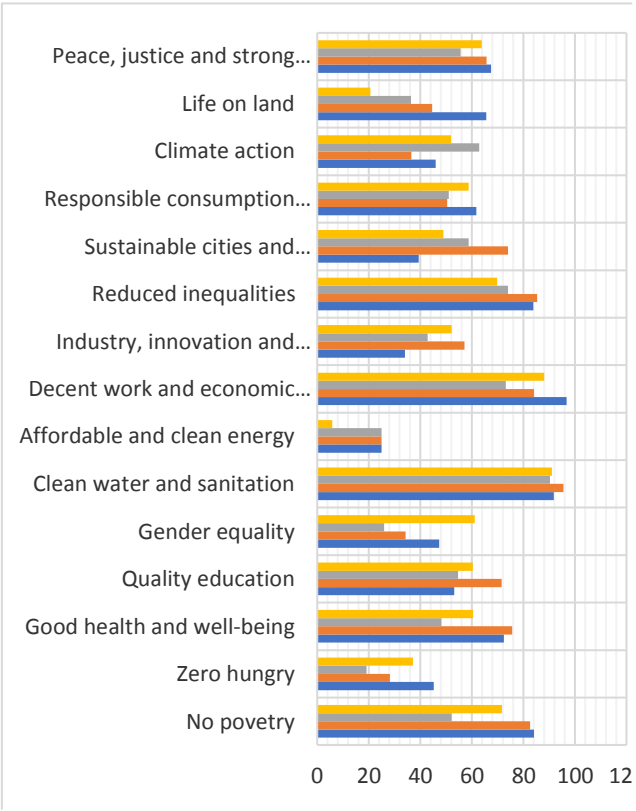


Figure 10 *Fulfilling the SDGs for the capital cities of the V4 countries for 2019.*

Source: Author processed data from https://euro-cities.sdgindex.org/#/, 2022

In the presented table 4, we identify in detail the position within the examined 15 SDGs and their indicators to point out the differences between the capital cities of the V4 countries. Due to the extensiveness of the data, we have highlighted the best values for the given parameter.

Table 4 European Cities SDG Index 2019 for capital cities of V4

SDG	Indicator / Country	Bratislava	Prague	Budapest	Warsaw
No povetry	Severe material deprivation rate in cities (%)	**4.3**	4.5	10.3	6
	People at risk of poverty or social exclusion (%)	**8.6**	9.4	22.3	15.5
Zero hungry	Obesity rate (BMI <30), %	**20.5**	26	28.9	23.1
Good health and well-being	Traffic fatalities (per 10,000 population)	0.235	**0.131**	0.324	0.375
	Infant mortality rate (under 1) per 1,000 births	2.688	**1.631**	3.104	3.331
	General practitioners per (100,000 pop)	655.75	694.78	383.42	**281.13**
	Life expectancy (years)	78.9	**80.6**	77.6	78.4
	Daily smokers (%)	-	25.15928	24.27452	**20.3099**
	Active lifestyle (%)	-	32.12911	8.480226	**37.61886**
Quality education	Early leavers from education (% 18-24)	4.7	**1.6**	7.6	3.9
	Adults with upper secondary education (% 25-64)	96.2	**97.6**	89.9	93.6
	NEET rate (% 15-24)	7.9	**2**	6.8	7.4
	Satisfaction with schools (%)	55	**75**	51	61
	Four year-olds in early childhood education (%)	81.8	88.7	**91.9**	91
	Adult participation in learning (%)	5.8	**11.3**	7.8	5.7
	University appearances in rankings	0	**3.75**	2.25	2.25
Gender equality	Gender wage gap (% male wage)	19.65649	21.16667	18.27243	**10.85627**
	Women in regional assemblies (%)	22.2	**26.2**	9.1	37.3
	Gender gap in unemployment (%)	**5.6**	15.5	14.7	11.3
Clean water and sanitation	Waste water treated (%)	**99.9899**	100	-	-
	Population connected to Sewerage Treatment (%)	94.6	**97**	95.45	-
Affordable and clean energy	Renewable energy generated (%)	-	-	-	**8.2**
Decent work and economic growth	GDP per capita	**36000**	25000	18000	22000
	5 year average of Annual real GDP Growth Rates	1.821469	0.524288	0.643112	**2.705699**
	Long term unemployment Rate (%)	2	**0.5**	1.3	1.5
Industry, innovation and infrastructure	R&D expenditure (%)	1.84	**2.97**	1.88	1.74
	Access to Internet at Home (%)	85	**89**	**89**	84
	Patent applicants (per million pop)	9.513	30.548	**44.903**	36.415
	Community design applications (per million pop.)	13	**54.66667**	20.66667	120,3333
	Potential road accessibility	21282109	**23368954**	20687517	20433918
	Direct trains to other cities (per million pop.)	6.142857	**13.21429**	12.78571	7.928571
Reduced inequalities	Gini Coefficient (1-100)	26.5	25.9	30.4	**32.1**
Sustainable cities and communities	Concentration PM2.5 (microgr/m3)	**18.33268**	18.61826	25	26.29568
	Emission of nitrogen oxides (kg/km2)	7.461591	**3.850179**	3.920153	6.57321
	Satisfaction affordable housing (%)	14	28	**33**	24
	Housing cost overburden rate in urban areas (%)	**7.8**	13.4	10.9	9
	Recharging stations (per 10,000 people)	0.482947	0.437326	**0.581958**	0.14829
	Satisfaction public transport (%)	54	**86**	67	76
	Satisfaction cultural facilities (%)	20	**57**	33	30
	Sights & landmarks (per 100,000)	124	**340**	180	118
	Museums (per 100,000)	36	**309**	95	60
	Concerts & shows (per 100,000)	2	**136**	38	19
Responsible consumption and production	Municipal waste (kg/capita)	428.2513	353.3967	369.2608	**300.0388**
	Municipal recycling rate (%)	29.8	34.1	**35**	33.8
	Ground water of good chemical status (%)	59.8	21.2	79.5	**94.4**
	Surface water of good chemical status (%)	**95**	71.8	3.2	2.2
Climate action	CO2 Emissions (tonnes per capita)	-	9.9	**5.8**	7.5
Life on land	Natura 2000 Area in good quality (%)	33.49867	**54.93179**	54.64317	12.09313
	Urban green area (%)	**27.52673**	15.4483	13.50703	20.59227
	Soil sealing (%)	16.53372	32.4789	**45.29542**	42.39787
	Surface Water of Good Ecological Status (%)	**63**	13.7	9.7	3
Peace, justice and strong institutions	Burglaries (per 100,000)	**49.54104**	214.5928	308.5518	-
	Robberies (per 100,000)	**40.50526**	60.36667	85.12561	66.78683
	Intentional homocides (per 100,000)	2.025263	**1.249504**	1.82575	-
	Perception of neighborhood safety (%)	**84**	82	80	90
	Quality of local government	-64.619	**-33.596**	-76.416	-61.361
Σ	Ranking (45 european cities)	**26**	27	37	31
	Score	**60.2**	60.1	55.4	57.8

Source: Author processed data from https://euro-cities.sdgindex.org/#/, 2022

Identifying the dominant capital cities in the framework of the mutual comparison indicates their

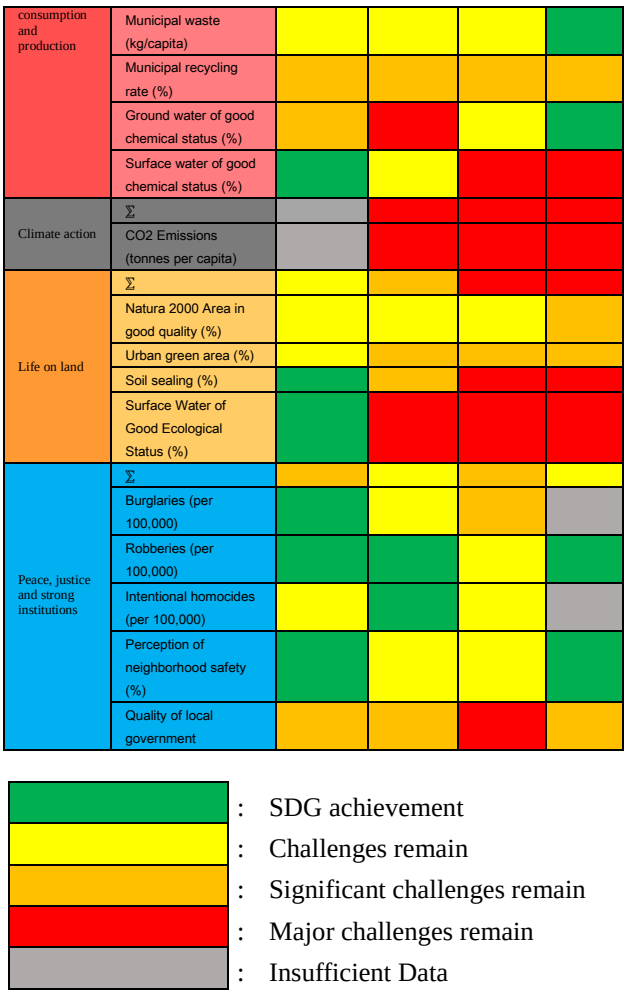
overall focus within the internal policy. As we can see in the case of the capital of Slovakia, Bratislava primarily dominated SDGs 1, 2, and 16; Prague dominated SDGs 4, 9 and 11; Budapest, on the other hand, in SDG 13 and Warsaw in SDG 10 and 12. In specific phenomena, Bratislava dominated the social area of life and safety. On the contrary, Prague dominated in the fields of education, innovation, infrastructure, and industry, as well as in the local communities. Budapest achieved good results in climate action and, on the contrary, Warsaw in gender inequality and waste management. At the same time, Bratislava finished best overall with a score of 60.2, while Prague lost only 0.1 points to Bratislava.

With the identified differences, we will now take a closer look at the state of current development, whether of the overall SDG indicator itself or the individual parameters of the given indicators. We have highlighted this development in Table 5 for the year 2019 with an outlook for other years for the capital cities of the V4 countries. In this case, we see a positive trend in SDGs 3 and 4 in almost all parameters for all the investigated cities. We note a highly positive trend in Bratislava as part of the indicator SDGs 1, 6, 8, 10, 15, and 16 and partly in SDG 9. In Prague, it also comes out in the framework of SDGs 1, 6, 8, 10, 11, and 16 and partially within SDG 9. Budapest, on the other hand, is partially within SDGs 11 and Warsaw within SDGs 10, 12 and 16.

Conversely, the negative trend is most dominant in Budapest, where it appears within the overall indicator of SDGs 2, 5, 7, and 13 and partially for indicator 15. For Warsaw, it is ultimately for indicator 13 and partially for 15. Prague has an entirely negative trend within SDG 2, 13 and partially for 5. Bratislava partially for indicators 4 and 11. Within indicator 4, all capital cities have a negative development trend despite positive activities in some of their parameters of this SDG 4. We can see more in table 5.

Table 5 Status of achievement of the SDGs indicator within V4 capital cities for 2019.

SDG	Indicator / Country	Bratislava	Prague	Budapest	Warsaw
No povetry	Σ				
	Severe material deprivation rate in cities (%)				
	People at risk of poverty or social exclusion (%)				
Zero hungry	Σ				
	Obesity rate (BMI <30), %				
Good health and well-being	Σ				
	Traffic fatalities (per 10,000 population)				
	Infant mortality rate (under 1) per 1,000 births				
	General practitioners per (100,000 pop)				
	Life expectancy (years)				
	Daily smokers (%)				
	Active lifestyle (%)				
Quality education	Σ				
	Early leavers from education (% 18-24)				
	Adults with upper secondary education (% 25-64)				
	NEET rate (% 15-24)				
	Satisfaction with schools (%)				
	Four year-olds in early childhood education (%)				
	Adult participation in learning (%)				
	University appearances in rankings				
Gender equality	Σ				
	Gender wage gap (% male wage)				
	Women in regional assemblies (%)				
	Gender gap in unemployment (%)				
Clean water and sanitation	Σ				
	Waste water treated (%)				
	Population connected to Sewerage Treatment (%)				
Affordable and clean energy	Σ				
	Renewable energy generated (%)				
Decent work and economic growth	Σ				
	GDP per capita				
	5 year average of Annual real GDP Growth Rates				
	Long term unemployment Rate (%)				
Industry, innovation and infrastructure	Σ				
	R&D expenditure (%)				
	Access to Internet at Home (%)				
	Patent applicants (per million pop)				
	Community design applications (per million pop.)				
	Potential road accessibility				
	Direct trains to other cities (per million pop.)				
Reduced inequalities	Σ				
	Gini Coefficient (1-100)				
Sustainable cities and communities	Σ				
	Concentration PM2.5 (microgr/m3)				
	Emission of nitrogen oxides (kg/km2)				
	Satisfaction affordable housing (%)				
	Housing cost overburden rate in urban areas (%)				
	Recharging stations (per 10,000 people)				
	Satisfaction public transport (%)				
	Satisfaction cultural facilities (%)				
	Sights & landmarks (per 100,000)				
	Museums (per 100,000)				
	Concerts & shows (per 100,000)				
Responsible	Σ				



Source: Author processed data from https://euro-cities.sdgindex.org/#/, 2022

Conclusion of RQ2

The current state of the capitals of the V4 countries indicates a growth trend in many indicators with subsequent potential for the next period. We recorded the highest score in this respect for Bratislava, which had a negative outlook only partially for SDGs 4 and 11, while the other V4 countries also had this for SDG 4. On the contrary, it had outstanding results in 6 and partly in one SDG, which constitutes a 47% share of the 15 SDGs examined. Prague is in a similar situation, which, on the contrary, is dominated by Bratislava in the field of education, while Bratislava is from the point of view of greenery. On the other hand, Budapest recorded a negative trend in several aspects of the SDG, and Warsaw had a more positive trend in waste management. We can therefore evaluate that Bratislava dominated more from the ecological and economic factors, Prague from the socio-economic factor and Warsaw from the technological factor. Despite this, the capital cities of the V4 were among the worst, with Bratislava occupying the best 26th place and Budapest up to 37th place among all European cities examined. This situation creates significant space for their subsequent development.

4 CONCLUSION

From the point of view of capital cities, the concept of SDGs has acquired a mandatory note of every city council of local city districts. This is also evidenced by the fact that the fulfilment of the goals of the SDG concept is closely related to their local policies. An example of this is that each city presented its vision of development until 2030, while each of them has a common element: the climate plan. They will focus on the gradual repair of local infrastructure with sustainable materials, afforestation, the support of sharing mobility or culture, the availability of housing, the reconstruction of public spaces, waste management or the gradual digitization of the entire city. This development will ensure the city's further growth, and together with innovations and possibilities, they will be able to secure the necessary interest from the point of view of tourism, which will have a direct effect on the development of the city. These phenomena will later ensure the transformation of cities from a linear economy to a circular economy, bringing new challenges, consequences, or trends to the surrounding satellite cities. This situation will prevent the practical and social limitations of places. It is the local system of cities that together creates the regional development of the given area, which creates the necessary stimulus for the subsequent academic but also a private investigation of the given issue with the implementation of the results on a practical level in order to ensure the fulfilment of the Paris Climate Agreement, Agenda 2030 and thus also the SDGs themselves

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