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P. 1-10
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COMPARATIVE ANALYSIS OF INDUSTRY, INNOVATION AND INFRASTRUCTURE OF SERBIA AND NEIGHBOURING COUNTRIES AS DETERMINANTS OF SUSTAINABILITY

Abstract

The quality of the innovation system and resilient and sustainable (educational, transport, information and communication) infrastructure are the most important determinants of sustainable development at the national level. The development that includes the transition to a knowledge-based economy implies sustainable development of the nations with the improvement of well-being. The aim of this paper is to point out the importance of specific indicators of industry, innovation and infrastructure as possible limiting factors of sustainability. The analysis is based on indicators of the 9 Goal of sustainable development for Serbia and five neighbouring countries for the period from 2017 to 2022. It will be concluded about the key advantages and disadvantages of analysed countries in relation to this goal of sustainable development.

Keywords: *innovation, sustainability, Serbia, neighbouring countries, comparative analysis*

JEL classification: *O32, O57, Q56*

КОМПАРАТИВНА АНАЛИЗА ПРИВРЕДЕ, ИНОВАЦИЈА И ИНФРАСТРУКТУРЕ СРБИЈЕ И ЗЕМАЉА У ОКРУЖЕЊУ КАО ДЕТЕРМИНАНТЕ ОДРЖИВОСТИ

Апстракт

Квалитет иновационог система и отпорна и одржива (образовна, транспортна, информациона и комуникациона) инфраструктура су најважније детерминанте одрживог развоја на националном нивоу. Развој који укључује прелазак на економију засновану на знању подразумева одрживи развој нација уз побољшање благостања. Циљ овог рада је да укаже на значај специфичних индикатора привреде, иновација и инфраструктуре као могућих ограничавајућих фактора одрживости. Анализа је заснована на индикаторима „Деветог циља одрживог развоја“ за Србију и пет земаља у окружењу

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за период од 2017. до 2022. године. Указаће се и на кључне предности и недостатке анализираних земаља у односу на овај циљ одрживог развоја.

Кључне речи: *иновација, одрживост, Србија, земље у окружењу, компаративна анализа*

Introduction

One of the important goals of sustainable development refers to the improvement of research activity, innovation systems of countries, the adoption of new technologies and the development of industrial enterprises with a qualified workforce. It is about the 9th goal of sustainable development, which is based on resilient (educational, innovation, information, communication, transport) infrastructure and encouraging inclusive industrialization. Inclusive and resilient industrialization implies the transition from the agriculture sector to the manufacturing sector, in order to meet the 2030 target and encourage investment in scientific research and innovation. This goal requires calculation on the basis of 7 indicators based on certain data from different official databases. In order to achieve the goals related to the determined indicators, specific targets were defined which should be achieved by a certain period of time. These targets indicate practical goals that are expected to be realized, especially in developing and least-developed countries.

The paper will present a comparative analysis of indicators of industry, infrastructure and innovation in Serbia and neighbouring countries (Serbia, Bulgaria, Croatia, North Macedonia, Bosnia and Herzegovina, Albania) in order to see the key limitations in achieving Goal 9 of sustainable development, especially through a comparative analysis. This analysis will enable an overview of the indicators in which certain countries of the region are the worst, and which represent their advantages in relation to other countries in the surrounding area.

1. Literature review

Goal 9 - *Industry, Innovation and Infrastructure within Sustainable Development Goals* (SDG9) is founded on resilient and sustainable innovation, as well as other infrastructure that allows for affordable and equitable access for all as well as inclusive and sustainable industrialization. It seeks to include small businesses in value chains as a crucial source of national innovation (Cvetanović, & Sredojević, 2012; Gupta & Vegelin, 2016). Industrialization entails structural change for developing economies from traditional sectors to a contemporary manufacturing industry based on innovation and technology that supports new technologies and generates employment (Sredojević, et al., 2016; Kynčlová et al., 2020).

It is focused on increasing the "connectivity and productivity of developing countries' industries and building resilient infrastructure systems to bolster economic growth" (CSIS, 2020). This goal is focused on the modernization of the economy, the construction of a quality innovation system and information and communication

technology (ICT) at the national level, especially the application of technological achievements, the development of an educated and qualified workforce that will contribute to the transition to the knowledge economy and the growth of labour productivity. In addition, it is based on the development of the academic community. All these indicators will ultimately contribute to the growth of the living standard of the population. Sustainable industrialization at the global level requires doubling the share of industry in the job market and the product in the least developed countries, as well as the modernization of the infrastructure based on a sustainable economy, efficient usage of material resources and clean and environmentally friendly technology and processes (Szopik-Depczyńska et al., 2018).

Within Goal 9, a distinction is made between developing countries and least developed countries, which are specifically targeted by this goal. Through the development of innovative capabilities, acceptance of new technologies, efficient use of available resources, enhancing international trade, and especially investments in science and research, the goal is to increase quality employment and income in these countries (UN, 2022). In addition, nuclear science and nuclear technology play a very important role in finding cost-effective and innovative ways of "building resilient infrastructure, promoting inclusive and sustainable industrialization and fostering innovation". Nuclear technology is useful in order to improve the safety and quality of products and also to increase industrial productivity. It can also make "processes more efficient, environmentally friendly and cost-effective" (IAEA, 2022).

In terms of technology and innovation, high-tech industries are more environmentally friendly while they pollute less than others, especially the recycling industry which can be labelled as a green industry. The procurement of green technologies and the development of green innovations improve employment and directly contribute to the achievement of Goal 9 and other sustainable development goals, but also contribute to the reduction of energy intensity (Chakraborty & Mazzanti, 2020).

Considering ICT "more than half of the world's population is now online and almost the entire world population lives in an area covered by a mobile network. It is estimated that in 2019, 96.5 per cent were covered by at least a 2G network". These trends are particularly accelerated by the effects of the COVID-19 pandemic (digitalization of services, including access to healthcare, education and other essential services). However, on the other hand, there is a global problem associated with investments in research and development, which, although growing significantly since 2000, in developing countries are below 1% of GDP (UN, 2022) which slows down the creation of quality jobs in these countries and innovative activity.

2. Research methodology

Goal 9 consists of the following 7 indicators: 1) Population using the internet (%) – I1, 2) Mobile broadband subscriptions (per 100 population) – I2, 3) Quality of overall infrastructure (1= extremely underdeveloped; 7= extensive and efficient by international standards – I3, 4) Logistics Performance Index: Quality of trade and transport-related infrastructure (worst 1–5 best) – I4, 5) The Times Higher Education Universities Ranking: Average score of top 3 universities (worst 0–100 best) – I5, 6) Scientific and

technical journal articles (per 1,000 population) – I6, 7) Expenditure on research and development (% of GDP) – I7 (Sachs et al., 2020). Namely, it is one of 17 Sustainable Development Goals - 1) No poverty, 2) Zero hunger, 3) Good health and well-being, 4) Quality education, 5) Gender equality, 6) Clean water and sanitation, 7) Affordable and clean energy, 8) Decent work and economic growth, 9) Industry, innovation and infrastructure, 10) Reduced inequalities, 11) Sustainable cities and communities, 12) Responsible consumption and production, 13) Climate action, 14) Life below water, 15) Life on land, 16) Peace, justice and strong institutions, 17) Partnerships for the goals (Sachs et al., 2020).

The calculation of this goal of sustainable development (Goal 9 - Industry, Innovation and Infrastructure) is based on the following data: the number of people who have access to the Internet, the degree of development of the industry (the presence of certain sectors), access to critical infrastructure (education, transport, healthcare, innovation capacities, information and communication systems), access to mobile connectivity, electricity and sanitation (CSIS, 2020).

In order to realize this goal, certain targets are foreseen, which are shown in Table 1.

Table 1: Goal 9 targets and related indicators (with data source)

Target No	Explanation of target	Related indicators (with data sources for each indicator)
9.1	In order to promote economic development and human well-being, build dependable and resilient infrastructure (including regional and trans-border infrastructure), with an emphasis on equal access	1. Proportion of the rural population who live within 2 km of an all-season road (World Bank II) 2. Passenger and freight volumes, by mode of transport (ICAO, ITF-OECD)
9.2	Encourage inclusive and sustainable industrialization by boosting the sector's contribution to GDP and employment by a large amount by 2030 (doubling it in the least developed nations)	1. Manufacturing value added as a proportion of GDP and per capita (UNIDO I) 2. Manufacturing employment as a proportion of total employment (UNIDO)
9.3	Expanding small business and other company access to financial services, especially in developing nations	1. Percentage share of small-scale industries in total industry value added (UNIDO II) 2. Percentage of small-scale industries with a loan or line of credit (UNIDO, World Bank)
9.4	Improve infrastructure to make it more sustainable (by increasing resource efficiency and expanding the use of green, eco-friendly products and methods)	1.CO_2 emission per unit of value added (UNIDO, IEA)

9.5	Enhance the technological and scientific capabilities of industrial sectors by 2030 (especially in developing nations), including fostering innovation, significantly increasing the number of workers engaged in research and development per million people, and increasing both public and private research and development spending	1. Research and development expenditure as a percentage of GDP (UNESCO-UIS I) 2. Researchers (in full-time equivalent) per million inhabitants
9.A	"Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States 18"	1. Total official international support (official development assistance plus other official flows) to infrastructure (OECD)
9.B	Supporting environmental policy as well as promoting industrial diversity and adding value to commodities can help technology development, research, and innovation systems in developing countries	1. Percentage of medium and high-tech manufacturing value added in total value added (UNIDO)
9.C	By 2020, the least developed countries will have increased access to information and communications technology (ICT) and will have affordable, universal Internet access	1. Percentage of the population covered by a mobile network, by technology (ITU)

Source: Adapted to UN (2022); Kynčlová et al. (2020)

Based on the comparative analysis of indicators within the 9th goal of sustainable development, critical factors of industry, innovation and infrastructure will be found in the following countries included in the analysis: Serbia (SER), North Macedonia (MAC), Albania (ALB), Bosnia and Herzegovina (B&H), Bulgaria (BUL) and Croatia (CRO).

3. Research results and discussion

The analysis of industry, innovation and infrastructure as determinants of sustainable development of Serbia and neighbouring countries is based on data about a score of the 9th goal of sustainable development including 7 indicators for a 6-years period. With the aim of analyzing the limiting factors and advantages of Serbia and neighbouring countries in terms of Goal 9, the average scores of all 7 indicators for each country, as well as the average scores of all 7 indicators per year for all countries, are presented in Table 2.

Table 2: SDG9 indicators – Serbia and neighbouring countries (2017-2022)

	Year	SER	MAC	ALB	B&H	BUL	CRO	Average per year for all countries
I_1	**2022**	**78.4**	**81.4**	*72.2*	*73.2*	*70.2*	**78.3**	75.62
	2021	**77.4**	**79.2**	*69.6*	*69.9*	*67.9*	**79.1**	73.85
	2020	**73.4**	**79.2**	*71.8*	*70.1*	*64.8*	**75.3**	72.43
	2019	**70.3**	**76.3**	**71.8**	*69.5*	*63.4*	*67.1*	69.73
	2018	**67.1**	**72.2**	**66.4**	*54.7*	*59.8*	**72.7**	65.48
	2017	**65.3**	**70.4**	*63.3*	65.1	*56.7*	**69.8**	65.10
Average per indicator (2017-22)		**71.98**	**76.45**	*69.18*	*67.08*	*63.80*	**73.72**	70.37
I_2	**2022**	**90.3**	*64.9*	*62.1*	*47.3*	**105.6**	**82.1**	75.38
	2021	*71.3*	*64.9*	*62.1*	*47.3*	**105.6**	**82.1**	72.22
	2020	*66.0*	*64.7*	*62.8*	*55.4*	**101.0**	**79.5**	71.57
	2019	**77.0**	*60.8*	*69.3*	*43.4*	**91.6**	**79.7**	70.30
	2018	**72.8**	*57.1*	*57.6*	*40.5*	**87.4**	**77.2**	65.43
	2017	**71.8**	*56.2*	*40.6*	*33.5*	**81.3**	**75.4**	59.80
Average per indicator (2017-22)		**74.87**	*61.43*	*59.08*	*44.57*	**95.42**	**79.33**	69.12
I_3	**2022**	-	-	-	-	-	-	-
	2021	-	-	-	-	-	-	-
	2020	-	-	-	-	-	-	-
	2019	-	-	-	-	-	-	-
	2018	*3.5*	**4.1**	**4.3**	*3.4*	*3.9*	**4.7**	3.98
	2017	*3.2*	**4.1**	**4.1**	*3.2*	**3.9**	**4.4**	3.82
Average per indicator **(2017-22)**		*3.35*	**4.1**	**4.2**	*3.3*	3.9	**4.55**	3.9
I_4	**2022**	2.6	*2.5*	*2.3*	*2.4*	**2.8**	**3.0**	2.60
	2021	2.6	*2.5*	*2.3*	*2.4*	**2.8**	**3.0**	2.60
	2020	2.6	*2.5*	*2.3*	*2.4*	**2.8**	**3.0**	2.60
	2019	2.6	*2.5*	*2.3*	*2.4*	**2.8**	**3.0**	2.60
	2018	*2.5*	**2.6**	*2.0*	**2.6**	*2.4*	**3.0**	2.52
	2017	2.6	2.6	*2.2*	2.6	2.6	**3.0**	2.60
Average per indicator (2017-22)		*2.58*	*2.53*	*2.23*	*2.47*	**2.70**	**3.00**	2.59

I_5	**2022**	**29.5**	*0.0*	*0.0*	*7.0*	**16.5**	**22.0**	12.50
	2021	**25.5**	*0.0*	*0.0*	*7.0*	**17.7**	**22.6**	12.13
	2020	**22.5**	*0.0*	*0.0*	*7.0*	**16.4**	**24.1**	11.67
	2019	**22.5**	*0.0*	*0.0*	*0.0*	**14.4**	**26.1**	10.50
	2018	*4.3*	*0.0*	*0.0*	*0.0*	**12.4**	**25.7**	7.07
	2017	**4.3**	*0.0*	*0.0*	*0.0*	**6.7**	*0.0*	1.83
Average per indicator (2017-22)		**18.10**	*0.00*	*0.00*	*3.50*	**14.02**	**20.08**	9.28
I_6	**2022**	**0.9**	*0.5*	*0.2*	*0.5*	**0.9**	**1.9**	0.82
	2021	**0.5**	*0.2*	*0.1*	*0.2*	**0.5**	**1.0**	0.42
	2020	**0.5**	*0.2*	*0.1*	*0.2*	**0.5**	**1.0**	0.42
	2019	**0.6**	*0.2*	*0.1*	*0.1*	0.4	**1.0**	0.40
	2018	**0.6**	0.3	0.1	0.1	0.4	1.0	0.42
	2017	*0.7*	*0.2*	**4.8**	*0.1*	*0.4*	*0.8*	1.05
Average per indicator (2017-22)		**0.63**	*0.27*	**0.78**	*0.20*	*0.52*	**1.12**	0.59
I_7	**2022**	**0.9**	*0.4*	*0.2*	*0.2*	**0.8**	**1.0**	0.58
	2021	**0.9**	*0.4*	*0.2*	*0.2*	**0.8**	**1.0**	0.58
	2020	**0.9**	*0.4*	*0.2*	*0.2*	**0.8**	**0.9**	0.57
	2019	**0.9**	*0.4*	*0.2*	*0.2*	**0.8**	**0.9**	0.57
	2018	**0.9**	*0.4*	*0.2*	*0.2*	**1.0**	**0.9**	0.60
	2017	**0.8**	*0.4*	*0.15*	*0.3*	**0.8**	**0.5**	0.49
Average per indicator (2017-22)		**0.88**	*0.40*	*0.19*	*0.22*	**0.83**	**0.87**	0.57

Source: Sachs et al. (2017, 2018, 2019, 2020, 2021, 2022)
**Note: Bold marked above average, italics below average for each year*

Table 2 indicates that regarding indicator 1 - Population using the internet (%), North Macedonia records the best result of all 6 analysed countries, while Bulgaria is the country with the lowest percentage of the population that uses the Internet, in the analysed six-year period. Considering indicator 2 - Mobile broadband subscriptions, the highest score is achieved by Bulgaria, while the worst is achieved by Bosnia and Herzegovina. Analysing the third indicator - Quality of overall infrastructure, we conclude that Croatia achieves the best results, and Bosnia and Herzegovina the worst, but Serbia is very close. Including the fourth indicator - Logistics Performance Index, Croatia is in the first place, followed by Bulgaria, while Albania is in last place, but Bosnia and Herzegovina is also close. Bearing in mind the fifth indicator - The Times Higher Education Universities Ranking, the best score is achieved by Croatia, followed by Serbia and Bulgaria, while the biggest problem and weakness, when it comes to indicators within the 9 goals for North Macedonia and Albania, is precisely this indicator. Taking into account the sixth indicator - Scientific and technical journal articles, Croatia achieves the best results, followed by Albania and Serbia, while Bosnia and Herzegovina achieves the worst. Analysing the last indicator - Expenditure on research and development (% of GDP), it

can be concluded that this is Serbia's key advantage, bearing in mind that it achieves the best result of all the countries in the region, followed by Croatia and Bulgaria, and the worst countries from this aspect are Albania and Bosnia.

Table 3: Indicators within Goal 9 which require priority of development policy by analysed countries (2017-2022)

Country	The critical indicators which are below the average score of the group of analysed countries	Number of critical indicators
Serbia	I_3, I_4	2
North Macedonia	I_2, I_4, I_5, I_6, I_7	5
Albania	I_1, I_2, I_4, I_5, I_7	5
Bosnia and Herzegovina	I_1, I_2, I_3, I_4, I_5, I_6, I_7	7
Bulgaria	I_1, I_3, I_6	3
Croatia		0

Source: Author's calculation

Table 3 shows that Bosnia and Herzegovina, with 7 critical indicators, is the worst-positioned analysed country, especially considering that it has the worst performance in all analysed indicators. This would mean that this country must take immediate action in all these areas of innovation and infrastructure development. Similar results are achieved by Albania and North Macedonia, with 5 critical indicators each. Serbia is in the second-best place, bearing in mind that it has only 2 critical indicators, and right after Serbia is Bulgaria, with 3 critical indicators. It is interesting that Croatia does not have critical indicators, considering that for each indicator within *Goal 9 of sustainable development*, it had a score above the average of the analysed countries in the surrounding area.

Conclusion

The results obtained from the comparative analysis of Serbia and neighbouring countries with regard to the 9th goal of sustainable development lead to the following conclusions:

- Serbia achieves poor performance in two indicators - Quality of overall infrastructure and Logistics Performance Index: Quality of trade and transport-related infrastructure, which points to the necessity of directing public policies to the improvement of transport infrastructure, information and communication infrastructure, improvement of the innovation system, and trade quality.
- North Macedonia particularly records bad results in the science sector, when it comes to the ranking of universities and the number of scientific journals, which requires a policy of reforms in the field of science and innovation activity in order to raise the quality in this sector.
- Albania achieves the worst results in ranking of universities, transport

infrastructure, quality of trade and allocation for research and development activities, which is the worst of all analysed countries.

- Bosnia & Herzegovina records the worst results regarding indicators 2, 3, 5 and 6 comparing all 6 neighbouring countries. It implies that this country should focus public policies on the development of the overall infrastructure, on the improvement of universities and scientific journals, and quality of science, while encouraging the population to use mobile broadband subscriptions.
- Bulgaria could improve its position by encouraging the population to use the Internet, directing policies towards the development of the overall infrastructure (transport, education, information and communication), and strengthening the quality and number of scientific and technical journal articles.
- Croatia is the only country out of all the analysed countries that does not have critical factors, i.e. in all indicators it achieves a score above the average for the six-year period for countries in the region (out of a total of 6 countries).

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References

Chakraborty, S. K., & Mazzanti, M. (2020). Energy intensity and green energy innovation: Checking heterogeneous country effects in the OECD. *Structural Change and Economic Dynamics,* 52, 328–343.

CSIS (2020). *Sustainable Development Goal #9: Industry, Innovation and Infrastructure*. Retrieved from: https://www.csis.org/events/sustainable-development-goal-9-industry-innovation-and-infrastructure, Accessed on 15 October 2022

Cvetanović, S., & Sredojević, D. (2012). Koncept nacionalnog inovacionog sistema i konkurentnost privrede. *Economic Themes*, *50*(2), 167-185.

Sredojević, D., Cvetanović, S., & Bošković, G. (2016). Technological changes in economic growth theory: neoclassical, endogenous, and evolutionary-institutional approach. *Economic Themes*, *54*(2), 177-194.

Gupta, J., & Vegelin, C. (2016). Sustainable development goals and inclusive development. International environmental agreements: *Politics, law and economics*, 16(3), 433-448.

IAEA (2022). *Sustainable Development Goal 9: Industry, innovation and infrastructure*. Retrieved from: https://www.iaea.org/about/overview/sustainable-development-goals/goal-9-industry-innovation-and-infrastructure, Accessed on 8 October 2022

Kynčlová, P., Upadhyaya, S., & Nice, T. (2020). Composite index as a measure on achieving Sustainable Development Goal 9 (SDG-9) industry-related targets: The SDG-9 index. *Applied Energy*, 265, 114755.

Sachs, J., Kroll, C., Lafortune, G., Fuller, G., & Woelm, F. (2021). *The Decade of Action for the Sustainable Development Goals: Sustainable Development Report 2021.* Cambridge: Cambridge University Press.

Sachs, J., Lafortune, G., Kroll, C., Fuller, G., & Woelm, F. (2022). *From Crisis to Sustainable Development: the SDGs as Roadmap to 2030 and Beyond.* Sustainable Development Report 2022. Cambridge: Cambridge University Press.

Sachs, J., Schmidt-Traub, G., Kroll, C., Durand-Delacre, D., & Teksoz, K. (2017). *SDG Index and Dashboards Report 2017*. New York: Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN).

Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G., Fuller, G., & Woelm, F. (2020). *The Sustainable Development Goals and COVID-19.* Sustainable Development Report 2020. Cambridge: Cambridge University Press.

Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G., & Fuller, G. (2019). *Sustainable Development Report 2019*. New York: Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN).

Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G., & Fuller, G. (2018). *SDG Index and Dashboards Report 2018*. New York: Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN).

Szopik-Depczyńska, K., Kędzierska-Szczepaniak, A., Szczepaniak, K., Cheba, K., Gajda, W., & Ioppolo, G. (2018). Innovation in sustainable development: an investigation of the EU context using 2030 agenda indicators. *Land use policy*, 79, 251-262.

UN (2022). *Goal 9: Build resilient infrastructure, promote sustainable industrialization and foster innovation*. Retrieved from: https://www.un.org/sustainabledevelopment/infrastructure-industrialization/, Accessed on 1 October 2022