SCIENTIFIC REVIEW

CIRCULAR ECONOMY ASSOCIATED WITH COMPETITIVENESS AND INNOVATION

STOIMENOV Suzana[1], GRAČANAC Aleksandar[2], RADOSAVAC Adriana[3], JAKOPIN Edvard[4], MOMČILOVIĆ Oliver[5]

[1]University " Union- Nikola Tesla", Faculty of Enterpreneurial Bussines and Real Estate Management, Belgrade (SERBIA) ORCID 0009-0001-0300-3296,
[2] University " Union- Nikola Tesla", Faculty of Enterpreneurial Bussines and Real Estate Management, Belgrade (SERBIA) ORCID 0000-0002-5792-4752,
[3] University Business Academy in Novi Sad, Faculty of Applied Management, Economics and Finance in Belgrade (SERBIA) ORCID 0000-0001-8639-6189,
[4] University " Union- Nikola Tesla", Faculty of Economy and Finances, Belgrade, Serbia (SERBIA) ORCID 0000-0003-2367-895X
[5] University Business Academy in Novi Sad, Faculty of Applied Management, Economics and Finance in Belgrade (SERBIA) ORCID 0000-0002-2926-3475

E-mail: stoimenovsuzana@gmail.com, agracanac@unionnikolatesla.edu.rs, adriana.radosavac@mef.edu.rs, edvard.jakopin@stat.gov.rs, oliver.momcilovic@mef.edu.rs

ABSTRACT

The aim of this study is estimation differences among countries in Europe according to level of developed circular economy. Eurostat database used for study indicators of competitiveness and innovation for 26 Countries for three years period. The level of developed circular economy analyzed toward to four sub-indicators: gross investment in material goods, number of employees, patents for climate change mitigation technologies, added value by factor costs, number of patents for climate change mitigation technologies amount of patents/year. The best value for each sub-indicators found for Germany and only for added value by factor costs was found for France in 2018 year. The lowest value for gross investment in material goods, patents for climate change mitigation technologies, was in Bosnia and Herzegovina and for number of employees in Iceland in each year, while the lowest added value by factor costs was in first year in Croatia in second in Slovenia and in third year in Bulgaria, Croatia, Cyprus, Latvia and Greece.

Keywords: *circular economy, production, investment, waste management, competitiveness, innovation policy*

JEL: Q52
DOI: 10.5937/intrev2404171S
UDC: 330.31:330.341.1
339.13
COBISS.SR-ID 160148745

INTRODUCTION

The basic principles of the circular economy are the reduction of the extraction of all resources, the reduction of the amount of waste materials, the reuse of materials from products that have completed their life cycle, development of innovation technology for reducing the cost of resources and the use of energy. This results in economic savings, which is the basis of economic growth [1]. The waste, generally is not clear determined. Most often waste classified as municipal waste, but in some countries, waste classified as industrial, agricultural, medical, construction. It was estimated that waste in cities can use as food, which amount estimated over 1.3 billion tons in 2012 [2].

The innovative approach for using organic waste, is chance for using of plant vegetative organs and fruits in processing represents transformation of waste into animal feed in agriculture. Also, urban domestic sewage and industrial waste water can be treated and reused for agriculture, watering of green space and other uses. Composting is environmentally safe and most agronomically waste management system which can used for the recycling of organic matters into useful products. The compost can use as a soil conditioner, organic fertilizer and contribute to improvement of soil nutrients required for plants [3] and significantly reduction of volume, weight and water content of the waste as well as producing inactive pathogenic organisms [4].

For efficient recycling of food waste should be include all service enterprises (groceries, farmers, markets and restaurants) for collecting waste. For instance, percentage of organic waste had share 45% and more in environment which consists compostable organic materials, and can use in recycling by using biological processes and new innovative methods [5], [6], [7]. The developing new policy based on innovation make contribution new in advances integrated of resources management through a global network and cooperation companies for research and application innovation technology to create economic growth and circular economy.

The circular economy promotes concepts such as recycling, refurbishing, repairing, reusing and sharing products. Instead of simply discarding products at the end of their life cycle, materials are returned to the manufacturing process to create new products. This approach reduces the need to extract new raw materials and the energy needed to produce new products [8], [9], [10]. The circular economy brings numerous advantages. First, the pressure on natural resources is reduced, because the existing resources are used to the maximum. This reduces the ecological footprint of production and consumption. Second, the circular economy encourages innovation and creates new economic opportunities, such as repair, recycling, renewal and overhaul services. Third, more efficient use of resources and reduction of waste lead to lower costs in the supply chain, resulting in economic savings [11], [12], [13], [14].

The circular economy brings a number of innovative approaches that differ from traditional linear models of production and consumption [15]. This includes designing products for circularity, focusing on easily degradable, repairable and reusable products. Also, recycling and recovery play a key role, along with the development of advanced technologies for turning waste into new raw materials and products [16], [17]. The concept of sharing economy encourages the joint use of resources, while digital technologies enable process monitoring and optimization. Innovative financial mechanisms and business models that support the long-term sustainability of the circular economy are also needed. All these innovations together make it possible to reduce the extraction of new resources, reduce waste and achieve economic savings [18], [19], [20].

Circular economy indicators include recycling rate, reuse rate, material efficiency index, carbon footprint and circular added value [21]. These indicators serve to measure the progress and efficiency of the circular economy, providing information on the use of resources, waste reduction, greenhouse gas emissions and economic benefits [22]. They enable the monitoring and evaluation of the implementation of the circular economy at different levels and contribute to achieving sustainable development and reducing the negative impact on the environment [23], [24], [25].

The aim of this paper is a comparative analysis of the degree of development of the circular economy in European countries in the period 2017-2019. years, based on four sub-indicators from the thematic area of competitiveness and innovation (i) gross investment in material goods, (ii) number of employees, (iii) added value by factor costs and (iv) patents for climate change mitigation technologies for wastewater treatment or waste management.

MATERIALS AND METHODS

In this research used data for circular economy indicators from the area of competitiveness and innovation, from the official website of the European Commission (Eurostat website) for the period 2017-2019 and forming a tabular form. Collected data used for comparing values of sub-indicators among countries as a measure of the development of the circular economy among countries. Statistical processing of data taken from the Euostat website in order to compare data, by determining the "**z "score** and percentage ranking. In order to compare the available values of the sub-indicators, and for the countries under analysis, a z-score or z-score was calculated and it provides a meaningful comparison between the data sets.

"**Z"** score computed according to formula:

$$Zscore = \frac{X - M}{SD}$$

X= sub-indicator value for a specific country, *M*= average (mean value), *SD* = standard deviation;

Z-score represents, "A numerical measurement that describes the relationship between a value and the mean of a group of values and is measured in terms of standard deviations from the mean" [26]. Among the 10 defined indicators by European Commission [27] for this study the Indicators of competitiveness and innovation was analyzed in association with a) indicator of private investment, jobs and gross added value was analyzed through sub-indicators (Gross investment in material goods, number of employees and added value by factor costs); b) indicator the number of patents related to recycling and secondary raw materials was analyzed through the sub-indicator (Patents for climate change mitigation technologies related to wastewater treatment or waste management).

HYPOTHESE

Based on the aforementioned analysis of the concept of circular economy and the associated sub-indicators from the analyzed area of competitiveness and innovation, we set the following hypotheses:

H1: Circular economy is not equally applied in all countries

H2: Monitoring of circular economy indicators contributes to the fact that each individual country follows its own circular development trend economy

RESULTS

In the analysis of the first hypothesis (H1-Circular economy is not equally applied in all countries), we start from the position that the level of development of the circular economy in certain countries can be monitored through indicators, i.e. sub-indicators in the field of competitiveness and innovation : PI1 - gross investment in materials, EUR million/year, PI2 - number of employees/year, PI3 - added value by factor costs EUR million/year, PI4 - number of patents for climate change mitigation technologies number of patents/year.

The average value of sub-indicator PI1 (gross investment in material goods) in 2017 was 511.25 million Euros per year. The countries with the lowest value of gross investment in material goods are Bosnia and Herzegovina, Cyprus, Serbia, Bulgaria and Croatia Germany in 2017 amounted to 3195.60 million euros per year, which is six times more than the average value of all countries in 2017 year. Among the available data for the sub-indicator PI 1- gross investment in material goods are available values for Serbia and Bosnia and Herzegovina, but what is worrying is that there are countries for which there are no data (Iceland, Great Britain, Slovenia and France did not provide data) table 1.

*Table 1. Value of sub-indicators (P1, P2, P3 and P4) in 2017 year and its **z** score value*

	EU/candidate/ member states	PI1 EUR million /year	PI2 No employes /year	PI3 added value EUR million/year	PI4 No patents /year	PI1-z score	PI2-z score	PI3-z score	PI4-z score
1	Austria	372.30	66 628.00	4 144.50	6.33	-0.19	-0.44	-0.17	-0,40
2	Belgium	660.40	52 079.00	3 041.70	18.26	0.20	-0.51	-0.30	0,32
3	Bulgaria	90.50	60 750.00	636.90	0.22	-0.57	-0.47	-0.56	-0,77
4	Croatia	57.60	36 168.00	623.20	0.00	-0.62	-0.59	-0.57	-0,78
5	Denmark	244.50	39 596.00	2 384.20	5.67	-0.36	-0.58	-0.37	-0,44
6	Finland	187.70	40 412.00	1 984.90	17.83	-0.44	-0.57	-0.41	0,30
7	France	:	455 640.00	22 397.00	37.59	:	1.59	1.86	1,49
8	Netherlands	992.00	108 653.00	6 212.50	24.88	0.65	-0.22	0.06	0,72
9	Italy	1636.70	517440.00	18 632.90	26.85	1.53	1.91	1.44	0,84
10	Cyprus	23.10	8 101.00	197.90	0.00	-0.66	-0.74	-0.61	-0,78
11	Lithuania	97.60	37 708.00	475.30	0.00	-0.56	-0.59	-0.58	-0,78
12	Latvia	93.10	25 028.00	292.90	1.00	-0.57	-0.65	-0.60	-0,72
13	Hungary	181.20	85672.00	1 224.80	1.00	-0.45	-0.34	-0.50	-0,72
14	Germany	3195.60	659 271.00	32 080.30	68.16	3.65	2.65	2.94	3,35
15	Greece	95.40	63 084.00	644.80	1.75	-0.57	-0.45	-0.56	-0,68
16	Poland	762.40	359 286.00	5 199.70	34.25	0.34	1.09	-0.06	1,29
17	Portugal	238.80	88 565.00	1 548.30	1.00	-0.37	-0.32	-0.46	-0,72
18	Romania	387.80	133 062.00	1 485.20	8.49	-0.17	-0.09	-0.47	-0,27
19	Slovakia	175.70	42 219.00	669.30	2.26	-0.46	-0.56	-0.56	-0,65
20	Slovenia	:	20 376.00	560.30	0.99	:	-0.68	-0.57	-0,72
21	Spain	1 184.90	395 980.00	12 303.90	14.29	0.92	1.28	0.74	0,08
22	Sweden	484.60	79 015.00	4 220.20	12.61	-0.04	-0.37	-0.16	-0,02
23	Great Britain	:	484 724.00	2 6478.00	22.77	:	1.74	2.32	0,60
24	Iceland	:	3912.00	273.30	4.08	:	-0.76	-0.60	-0,54
25	Bosnia&Herzegovina	16.90	14 813.00	157.50	:	-0.67	-0.71	-0.62	:
26	Serbia	68.70	26 707.00	297.40	:	-0.60	-0.64	-0.60	:
	min	16.90 B&Herz	3912.00 Iceland	157.50 B&Herz	0.00 Croatia				
	max	3195.60 Germany	659 271.00 Germany	32 080.30 Germany	68.16 Germany				
	Average	511.25	150188.04	5698.73	**12,93**				
	st.deviation	734.51	191822.28	8975.91	16.51				

PI1 - gross investment in materials, EUR million/year; PI2 - number of employees/year; PI3 - added value by factor costs EUR million/year; PI4 - number of patents for climate change mitigation technologies number of patents/year

In terms of the PI2 parameter (number of employees/year) in 2017, Germany is in the leading first place, and far above the average value for this sub-indicator, which is 150,188.04. Countries that had values of this parameter above the average, among those analyzed are also: Great Britain, Spain, Romania, Poland, Italy and France (table 1).

Also, in terms of the value of sub-indicator PI3 (value added by factor costs EUR million/year) Germany is on first place. According to the value of this sub-indicator PI3, Serbia is far below the average value, which amounts to EUR 5698.73 million/year (table 1).

According to parameter PI4 (patents for climate change mitigation technologies) related to waste water treatment or waste management, Germany takes the leading place, followed by France and Poland. The average value according to the mentioned sub-indicator was **12.93** patents/year. Croatia has no patents in the mentioned year, but among the analyzed countries there are countries that did not submit data (Serbia and Bosnia and Herzegovina) table 1.

In order to compare the available values of the sub-indicators, and for the countries being analyzed, a z-score or z-score was calculated and it provides a meaningful comparison between the data sets. A positive z-score says that the data point is above the average. A negative z-score says that the data point is below the average. A z-score close to 0 means that the data point is close to the average.

Table 2. Average obtained on the basis z-score and Percentage ranks based on Z score-2017. year

	EU/candidate/ member states	**PI1**	**PI2**	**PI3**	**PI4**	**PI1 (%)**	**PI2 (%)**	**PI3 (%)**	**PI4 (%)**
1	Austria	-7.53	-17.00	-6.75	-15,54	42.5	33.0	43.3	34,46
2	Belgium	7.93	-19.50	-11.79	12,55	57.9	30.5	38.2	62,17
3	Bulgaria	-21.57	-18.08	-21.23	-27,94	28.4	31.9	28.8	22,06
4	Croatia	-23.24	-22.24	-21.57	-28,23	26.8	27.8	28.4	21,77
5	Denmark	-14.06	-21.90	-14.43	-17,00	35.9	28.1	35.6	33,00
6	Finland	-17.00	-21.57	-15.91	11,79	33.0	28.4	34.1	61,79
7	France	:	44.41	46.86	43,19		94.4	96.9	93,19
8	Netherlands	24.22	-8.71	2.39	26,42	74.2	41.3	52.4	76,11
9	Italy	43.70	47.19	42.51	29,95	93.7	97.2	92.5	79,95
10	Cyprus	-24.54	-27.04	-22.91	-28,23	25.5	23.0	27.1	21,77
11	Lithuania	-21.23	-22.24	-21.90	-28,23	28.8	27.8	28.1	18,94
12	Latvia	-21.57	-24.22	-22.57	-26,42	28.4	25.8	27.4	23,89
13	Hungary	-17.36	-13.31	-19.15	-26,42	32.6	36.7	30.9	23,89
14	Germany	50.00	49.60	49.84	49,96	100.0	99.6	99.8	99,96
15	Greece	-21.57	-17.36	-21.23	-25,17	28.4	32.6	28.8	24,83
16	Poland	13.31	36.21	-2.39	40,15	63.3	86.2	47.6	90,15
17	Portugal	-14.43	-12.55	-17.72	-26,42	35.6	37.5	32.3	23,58
18	Romania	-6.75	-3.59	-18.08	-10,64	43.3	46.4	31.9	39,36
19	Slovakia	-17.72	-21.23	-21.23	-24,22	32.3	28.8	28.8	25,78
20	Slovenia	:	-25.17	-21.57	-26,42		24.8	28.4	23,58
21	Spain	32.12	39.97	27.04	3,19	82.1	90.0	77.0	53,19
22	Sweden	-1.60	-14.43	-6.36	-0,80	48.4	35.6	43.6	49,20
23	Great Britain	:	45.91	48.98	22,57		95.9	99.0	72,57
24	Iceland	:	-27.64	-22.57	-20,54		22.4	27.4	29,46
25	Bosnia&Herzegovina	16.90	14 813.00	157.50	:	-0.67	-0.71	-0.62	:
26	Serbia	68.70	26 707.00	297.40	:	-0.60	-0.64	-0.60	:

PI1 - gross investment in materials, EUR million/year; PI2 - number of employees/year; PI3 - added value by factor costs EUR million/year; PI4 - number of patents for climate change mitigation technologies number of patents/year

The ***z***-score values of the sub-indicator results (PI1-PI4), for the countries under analysis, confirms the deviation of the values from the average values both in the positive direction and in the negative direction from the average value. By reviewing the percentage values of the sub-indicators (Germany had the highest percentage values for all four sub-indicators in 2017 - 100% or close to 100%, followed by Italy and Spain), an insight is gained into the degree of development of competitiveness and innovation of these countries compared to other countries (table 2).

Forming percentage values for the mentioned sub-indicators provides the possibility of reliable and high-quality comparison and ranking of countries. The values of sub-indicators for the year 2018 of the selected countries showed picture of the progress of the circular economy from the perspective of the sub-indicators (table 3).

Table 3. Value of sub-indicators (P1, P2, P3 and P4) in 2018. year and its Z score value

	EU/candidate/ member states	PI1 EUR million /year	PI2 No employes /year	PI3 added value EUR million/year	PI4 No patents/year	**PI1-z score**	**PI2-z score**	**PI3-z score**	**PI4-z score**
1	Austria	392.60	64799.00	3764.60	9.86	-0.22	-0.42	-0.23	-0,20
2	Belgium	744.60	54508.00	3022.50	15.67	-0.18	-0.47	-0.25	0,12
3	Bulgaria	117.30	60759.00	628.00	0.50	-0.26	-0.44	-0.30	-0,73
4	Croatia	97.40	41155.00	810.50	0.00	-0.26	-0.54	-0.30	-0,75
5	Denmark	282.30	41305.00	2463.70	5.63	-0.24	-0.54	-0.26	-0,44
6	Finland	:	:	:	16.10	:	:	:	0,15
7	France	:	:	222050.20	36.19	:	:	4.70	1,27
8	Netherlands	1132.70	111305.00	6654.40	33.72	-0.12	-0.18	-0.17	1,13
9	Italy	1944.90	518859.00	19457.40	21.27	-0.02	1.94	0.12	0,44
10	Cyprus	26.30	8804.00	220.90	0.00	-0.27	-0.71	-0.31	-0,75

11	Lithuania	69.10	37488.00	524.60	0.00	-0.27	-0.56	-0.31	-0,75
12	Latvia	48.50	23914.00	281.30	0.00	-0.27	-0.63	-0.31	-0,75
13	Hungary	242.20	91568.00	1691.50	2.00	-0.24	-0.28	-0.28	-0,64
14	Germany	34799.80	680199.00	34799.80	77.68	4.35	2.78	0.47	3,59
15	Greece	39.40	68879.00	628.00	0.00	-0.27	-0.40	-0.30	-0,75
16	Poland	707.40	358362.00	4966.70	22.25	-0.18	1.11	-0.21	0,49
17	Portugal	256.30	92059.00	1679.50	3.00	-0.24	-0.28	-0.28	-0,59
18	Romania	359.80	132551.00	1601.50	9.50	-0.23	-0.07	-0.28	-0,22
19	Slovakia	220.30	43109.00	751.60	1.50	-0.25	-0.53	-0.30	-0,67
20	Slovenia	:	20681.00	578.70	0.00	:	-0.65	-0.30	-0,75
21	Spain	1224.20	399028.00	12980.60	19.97	-0.11	1.32	-0.02	0,36
22	Sweden	572.80	75999.00	4142.90	14.84	-0.20	-0.36	-0.22	0,08
23	Great Britain	:	510098.00	27235.20	20.25	:	1.90	0.30	0,38
24	Iceland	:	3889.00	277.70	:	:	-0.73	-0.31	:
25	Bosnia&Herzegovina	16.90	14 813.00	157.50	:	-0.67	-0.71	-0.62	:
26	Serbia	68.70	26 707.00	297.40	:	-0.60	-0.64	-0.60	:
	min	21.00 B&Herz	3889.00 Iceland	171.60 B&Herz	0.00 Slovenia				
	max	34799.80 Germany	680199.00 Germany	222050.20 France	77.68 Germany				
	Average	2065.80	145103.58	14067.83	13.48				
	st.deviation	7516.42	192396.65	44246.12	17.86				

PI1 - gross investment in materials, EUR million/year; PI2 - number of employees/year; PI3 - added value by factor costs EUR million/year; PI4 - number of patents for climate change mitigation technologies number of patents/year

The minimum, maximum and average value of sub-indicators of countries (PI1-PI4) for 2018, indicate value of sub-indicators of countries comparing current values with average values in the specified year.

The average value of sub-indicator PI1 (gross investment in material goods/million EUR per year) in 2018 amounted to EUR 2065.80 million. As in the case of the previous year and previous indicators, there are significant differences between countries. The analyzed data show that Germany invested almost 17 times more than the average, i.e. 34799, 80 million EUR in 2018. Finland, France, Slovenia, Great Britain and Iceland did not submit data, and the countries of Cyprus, Lithuania, Latvia, Greece, Serbia, Bosnia and Herzegovina are far below the average. The high values of the circular economy indicators of individual countries lie in the increased efficiency of resources, which creates conditions for increased economic growth, and thus an increase in gross investment in material goods (table 3).

At the top of the list according to the values of the sub-indicator PI2 (number of employed / year) in 2018 is Germany, while Serbia, Bosnia and Herzegovina, Iceland, Sweden, Slovenia, Slovakia and Cyprus are far below the average value. This sub-indicator is an extremely good indicator for getting a picture of the circular economy trend, because the greater the number of employees in the area covered by CE, the greater the application of circularity (table 3).

As the circular economy is an economic concept linked to sustainable development, any progress in the area of the circular economy contributes to achieving the goals of sustainable development.

For sub-indicator PI3 in 2018 (value added by factor costs EUR million/year), the data show that France is far above the average value for 2018 (average: 14,067.83). Germany, Great Britain and Italy also recorded above average sub-indicator values (table 3).

The average value for sub-indicator PI4 (number of patents for climate change mitigation technologies - number of patents/year) was 11.02, while Germany also stood out for this sub-indicator, achieving the best results, i.e. maximum value (77.68). The countries highlighted by this sub-indicator are: France, the Netherlands, Great Britain, Poland and Spain. A large number of countries have a very bad result, i.e. the number of patents is equal to zero (Croatia, Cyprus, Lithuania, Latvia, Slovenia and Greece) table 3.

Finland is a country that did not submit data for 3 sub-indicators in 2018, but the values of its sub-indicators in 2017 were above the minimum values, as well as in 2019, so it remained among the countries being analyzed.

Innovative activity depends on the number of patents. On the one hand, patents are necessary for the realization of key changes, and innovation is necessary in order to achieve competitiveness and thus achieve the goals of circularity. As it takes a lot of time to create a competitive advantage, continuous innovative activities contribute to achieving a competitive advantage.

The values of the z-score results of the analyzed states showed percentage values of the sub-indicators (PI1-PI4) for countries that are the subject of the analysis (table 4).

Table 4. Average obtained on the basis z-score and Percentage ranks based on Z score-2018. year

	EU/candidate/ member states	**PI1**	**PI2**	**PI3**	**PI4**	**PI1 (%)**	**PI2 (%)**	**PI3 (%)**	**PI4 (%)**
1	Austria	-8,71	-17,36	-9,10	-7,93	41.29	32.64	40.90	42,1
2	Belgium	-7,14	-19,15	-9,87	4,78	42.86	30.85	40.13	54,8
3	Bulgaria	-10,26	-18,08	-11,79	-26,73	39.74	31.92	38.21	23,3
4	Croatia	-10,26	-21,57	-11,79	-27,34	39.74	28.43	38.21	22,7
5	Denmark	-9,48	-21,57	-10,26	-17,00	40.52	28.43	39.74	33,0
6	Finland				5,96	50.00	50.00	50.00	56,0
7	France			50,00	39,80	50.00	50.00	100.00	89,8
8	Netherlands	-4,78	-8,32	-6,75	37,08	45.22	41.68	43.25	87,1
9	Italy	-0,01	47,19	4,78	17,00	49.99	97.19	54.78	67,0
10	Cyprus	-10,64	-27,04	-12,17	-27,34	39.36	22.96	37.83	22,7
11	Lithuania	-10,64	-22,24	-12,17	-27,34	39.36	27.76	37.83	22,7
12	Latvia	-10,64	-24,54	-12,17	-27,34	39.36	25.46	37.83	22,7
13	Hungary	-9,48	-12,17	-11,03	-23,89	40.52	37.83	38.97	26,1
14	Germany	50,00	49,70	18,08	49,98	100.00	99.70	68.08	100,0
15	Greece	-10,64	-16,64	-11,79	-27,34	39.36	33.36	38.21	22,7
16	Poland	-7,14	35,99	-8,32	18,79	42.86	85.99	41.68	68,8
17	Portugal	-9,48	-12,17	-11,03	-22,24	40.52	37.83	38.97	27,8
18	Romania	-9,10	-3,98	-11,03	-8,71	40.90	46.02	38.97	41,3
19	Slovakia	-9,87	-21,23	-11,79	-24,86	40.13	28.77	38.21	25,1
20	Slovenia		-25,17	-11,79	-27,34	50.00	24.83	38.21	22,7
21	Spain	-4,38	40,15	-0,80	14,06	45.62	90.15	49.20	64,1
22	Sweden	-7,93	-15,17	-8,71	3,19	42.07	34.83	41.29	53,2
23	Great Britain		46,86	11,79	14,80	50.00	96.86	61.79	64,8
24	Iceland		-27,94	-12,17		50.00	22.06	37.83	50,0
25	Bosnia&Herzegovina	-10,64	-26,11	-12,17		39.36	23.89	37.83	50,0
26	Serbia	-10,26	-23,89	-12,17	-27,34	39.74	26.11	37.83	22,7

PI1 - gross investment in materials, EUR million/year; PI2 - number of employees/year; PI3 - added value by factor costs EUR million/year; PI4 - number of patents for climate change mitigation technologies number of patents/year

In order to monitor the trend of the sub-indicators (PI1-PI4), data for 2019 were also analyzed. The assumption is that based on the monitoring of the values of the sub-indicators in three years, an impression will be gained, which countries are approaching the goal or show a positive trend in reaching the goals of the circular economy, and which countries are moving away from the goal (table 5).

The average value of the sub-indicator PI1 (gross investment in material goods) in 2019 amounted to EUR 610.86 million year^{-1}. Out of the 26 countries, the 14 states had a value below the average. Germany had the highest value of sub-indicator PI1, namely 4206 million EUR, which is significantly more than other countries (table 5).

The implementation of the circular economy as a business model represents the possibility of opening new jobs. In this regard, the sub-indicator PI2 (number of employees/year) is an excellent indicator of the degree of implementation of the circular economy. The average value of the number of employees in 2019 was 141705,60, and the state Germany has the largest number of people employed in the circular economy/year. The number of employees above the average value was in Spain, Poland, Italy, France and Romania (table 5).

Table 5. Value of sub-indicators (P1, P2, P3 and P4) - 2019. year and its Z score value

	EU/candidate/ member states	PI1 EUR million /year	PI2 No employes /year	PI3 added value EUR million/year	PI4 No patents /year	**PI1-z score**	**PI2-z score**	**PI3-z score**	**PI4-z score**
1	Austria	409.20	65609.00	3763.00	9.90	-0.21	-0.40	-0.19	-0.17
2	Belgium	856.00	49491.00	3032.90	10.50	0.26	-0.49	-0.27	-0.14
3	Bulgaria	105.30	61941.00	709.30	0.00	-0.54	-0.42	-0.52	-0.69
4	Croatia	129.20	47664.00	964.20	0.00	-0.51	-0.50	-0.50	-0.69
5	Denmark	313.30	40677.00	2534.50	7.08	-0.32	-0.53	-0.33	-0.32
6	Finland	228.50	44229.00	2250.50	16.33	-0.41	-0.51	-0.36	0.16
7	France	:	453416.00	22613.90	38.78	:	1.64	1.85	1.33
8	Netherlands	1134.40	113628.00	6631.80	21.16	0.56	-0.15	0.12	0.41
9	Italy	1960.80	541600.00	20560.00	31.44	1.43	2.11	1.63	0.95
10	Cyprus	16.30	9073.00	244.70	0.00	-0.63	-0.70	-0.57	-0.69
11	Lithuania	69.10	38365.00	607.30	1.00	-0.58	-0.54	-0.53	-0.63
12	Latvia	62.10	22885.00	301.70	0.00	-0.58	-0.63	-0.57	-0.69
13	Hungary	259.50	90744.00	1581.00	1.00	-0.37	-0.27	-0.43	-0.63
14	Germany	4206.00	690330.00	37772.60	85.70	3.82	2.89	3.49	3.77
15	Greece	43.10	68247.00	735.00	0.00	-0.60	-0.39	-0.52	-0.69
16	Poland	925.70	366624.00	5678.20	15.25	0.33	1.19	0.01	0.11
17	Portugal	309.10	95644.00	1742.00	2.00	-0.32	-0.24	-0.41	-0.58
18	Romania	390.50	134266.00	1699.60	5.50	-0.23	-0.04	-0.42	-0.40
19	Slovakia	169.90	43511.00	758.20	3.67	-0.47	-0.52	-0.52	-0.49
20	Slovenia	:	20502.00	:	1.00	:	-0.64	:	-0.63
21	Spain	1125.60	419124.00	13874.50	17.05	0.55	1.46	0.90	0.20
22	Sweden	645.50	75849.00	4125.40	10.37	0.04	-0.35	-0.15	-0.15
23	Great Britain	:	:	:	25.83	:	:	:	0.66
24	Iceland		3941.00	261.50	:	-0.65	-0.73	-0.57	:
25	Bosnia&Herzegovina	22.70	16237.00	191.90	:	-0.63	-0.66	-0.58	:
26	Serbia	57.20	29043.00	334.80		-0.59	-0.59	-0.56	-0.69
	min	16.30 Cyprus	3941.00 Iceland	191.,90 B&Herz	0.00 Bg, Cro, ,Cyp Latv, Greece				
	max	4206.00 Germany	690330.00 Germany	37772.60 Germany	85.70 Germany				
	Average	610.86	141705.60	5540.35	13.20				
	st.deviation	940.88	189764.91	9223.03	19.25				

PI1 - gross investment in materials, EUR million/year; PI2 - number of employees/year; PI3 - added value by factor costs EUR million/year; PI4 - number of patents for climate change mitigation technologies number of patents/year

According to the values of the sub-indicator PI3 (added value by factor costs), Germany is also in first place, followed by France and Italy. The average value of sub-indicator PI4 (number of patents/year) in 2019 was 13.20, while the leader in the number of patents is Germany and that number was 85.70/year. The number of patents in Bulgaria, Croatia and Cyprus and Latvia is zero (table 5). Great Britain did not submit data for sub-indicators PI1, PI2 and PI3 in 2019, but as a country it was included in the consideration and analysis, because in fact in 2017 and 2018 it always had values above the minimum.

The values of the z-score results of the analyzed states showed percentage values of the sub-indicators (PI1-PI4) for countries that are the subject of the analysis. Therefore, according to the obtained values of the sub-indicators (PI1, PI2, PI3, and PI4), Germany is the leader in 2019 (table 6).

Table 6. Average obtained on the basis z-score and Percentage ranks based on Z score-2019. year

	EU/candidate/ member states	PI1	PI2	PI3	PI4	PI1 (%)	PI2 (%)	PI3 (%)	PI4 (%)
1	Austria	-8,32	-15,54	-7,53	-6,75	41,68	34,5	42,5	43,3
2	Belgium	10,30	-18,79	-10,64	-5,57	60,30	31,2	39,4	44,4
3	Bulgaria	-20,54	-18,08	-19,85	-25,49	29,46	31,9	30,2	24,5
4	Croatia	-19,50	-19,15	-19,15	-25,49	30,50	30,9	30,9	24,5
5	Denmark	-12,55	-20,19	-12,93	-12,55	37,45	29,8	37,1	37,5
6	Finland	-15,91	-19,50	-14,10	-6,40	34,09	30,5	35,9	43,6
7	France		44,95	46,78	40,82	50,00	95,0	96,8	90,8
8	Netherlands	21,23	-5,96	4,78	15,91	71,23	44,0	54,8	65,9
9	Italy	42,36	48,26	44,84	32,89	92,36	98,3	94,8	82,9
10	Cyprus	-23,57	-25,80	-21,57	-25,49	26,43	24,2	28,4	24,5
11	Lithuania	-21,90	-20,54	-20,19	-23,57	28,10	29,5	29,8	26,4
12	Latvia	-21,90	-23,57	-21,57	-25,49	28,10	26,4	28,4	24,5
13	Hungary	-14,43	-10,64	-16,64	-23,57	35,57	39,4	33,4	26,4
14	Germany	50,00	49,81	49,98	50,00	100,00	99,8	100,0	100,0
15	Greece	-22,57	-15,17	-19,85	-25,49	27,43	34,8	30,2	24,5
16	Poland	12,93	38,30	0,40	4,38	62,93	88,3	50,4	54,4
17	Portugal	-12,55	-9,48	-15,91	-21,90	37,45	40,5	34,1	28,1
18	Romania	-9,10	-1,60	-16,28	-15,54	40,90	48,4	33,7	34,5
19	Slovakia	-18,08	-19,85	-19,58	-18,79	31,92	30,2	30,4	31,2
20	Slovenia		-23,89		-23,57	50,00	26,1	50,0	26,4
21	Spain	20,88	42,82	31,59	7,93	70,88	92,8	81,6	57,9
22	Sweden	1,60	-13,68	-5,96	-5,96	51,60	36,3	44,0	44,0
23	Great Britain				24,50	50,00	50,0	50,0	74,5
24	Iceland	-24,22	-26,73	-21,57		25,78	23,3	28,4	50,0
25	Bosnia&Herzegovina	-23,57	-24,50	-21,90		26,43	25,5	28,1	50,0
26	Serbia	-22,24	-22,24	-21,20	-25,49	27,76	27,8	28,8	24,5

PI1 - gross investment in materials, EUR million/year; PI2 - number of employees/year; PI3 - added value by factor costs EUR million/year; PI4 - number of patents for climate change mitigation technologies number of patents/year

The above data, the statistical processing of sub-indicator values and the resulting analysis of the achieved level of development of the circular economy among the analyzed countries allow us to state that our first hypothesis ("Circular economy is not equally applied in all countries") has been confirmed.

OVERVIEW OF SUB-INDICATORS PI1-PI4 (%) FOR THE PERIOD 2017-2019 AND ANALYSIS OF EFFICIENT COUNTRIES

In order to review the hypothesis H2: Monitoring circular economy indicators contributes to the fact that each individual country follows the trend of circular economy development, a comparative analysis was performed for each country a comparative analysis of sub-indicators was performed for each country for the period from 2017-2019.

The monitoring of sub-indicators is very important both from the aspect of comparison between countries, and from the aspect of monitoring the development trend of the circular economy of a certain country. The system of measurement through percentage indicators of sub-indicator values (PI) was used in the work to monitor the development trend of the circular economy. Considering that the subject of the work is the area of competitiveness and innovation, were presented and analyzed values of individual sub-indicators of certain countries by year.

The percentage values of the sub-indicator PI1(%) for the period 2017-2019 show that Germany had the maximum values of the sub-indicator every year (100%) which followed value of PI1(%)in Italy and Spain. The high value of PI 1(%) indicate that the concept of circular economy has been developed and that is results high gross investment in material goods, particularly in Germany. Countries that do not have a high degree of recycling of materials estimated by the PI1(%) sub-indicator, which includes Serbia and Bosnia and Herzegovina, should be adopt practices applied in countries with high values of the sub-

indicator and thus enable improvement in the direction of circular economy development. The reasons for such a good implementation of CE in Germany are effective strategies set in time and clearly set goals in achieving CE, which every country should strive for (Figure 1).

The sub-indicator PI2(%) refers to the number of employees in CE-related fields including the creation of new jobs as well as the increase in the number of jobs. The increase in the number of employees in the field of CE is proof of the development of a circular economy in a country. Germany is also in the first place in terms of values for this indicator in every three years (2017-99.60%; 2018-99.70%; 2019-99.81%), and Spain, Poland and France follow it. In certain countries such as Serbia and Bosnia and Herzegovina, there is a low level of development and sub-indicator PI2 (%), and those countries had a low level of development and sub-indicator PI1(%).

The best results in terms of reaching the value of the sub-indicator PI3(%) value added by factor costs were also achieved by Germany. The goals of reaching high values of the sub-indicator PI3(%) were achieved except for Germany and in Great Britain, Italy and France. Nowdays in time of intense competition and the pursuit of economic growth, monitoring the value of the sub-indicator PI3(%), creates opportunities to improve the competitive advantage of a given country.

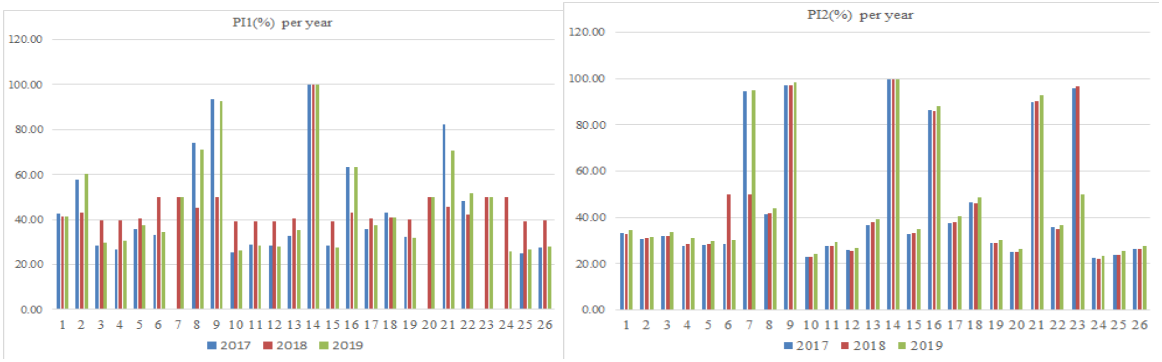

Figure 1. Variation percentage values of a) PI1 - gross investment in materials; b) PI2 - number of employees/year, in European Countries for three years period (2017-2019)

The ability of countries to build a competitive position takes a lot of time, and that is why it is very important to start as early as possible and, if possible, rely on the good practice of successful states.

According to value of sub-indicator PI4-number of patents in the area of the circular economy, the most successful country was Germany in all three years (2017-99.97%; 2018-100%; 2019-100%), which followed France, Belgium and Finland. The lowest values of the sub-indicator PI4(%) were recorded in Serbia and Bosnia and Herzegovina.

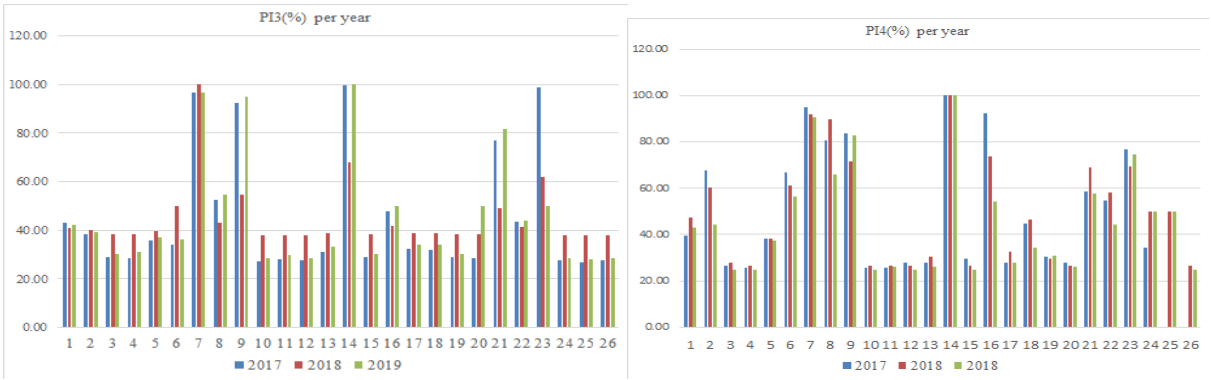

Figure 2. Variation percentage values of a) PI3 - added value by factor costs EUR million/year; b) PI4 - number of patents for climate change mitigation technologies number of patents/year , in European Countries for three years period (2017-2019)

We can state that all of the above confirms our second hypothesis ("Monitoring circular economy indicators contributes to the fact that each individual country follows the trend of circular economy development").

DISCUSSION

The summarizing analyzed data showed that some of the countries have already advanced a lot in reaching the goals of the circular economy, while some are at the very beginning of the process. The comparative analysis of indicators from the selected area ofcompetitiveness and innovation enabled the countries to be informed about their status regarding the transition to the circular economy. For some countries, there were no data for some of the sub-indicators, while some countries very often had low values. The material cycles should be closed as far as possible by making waste available to the economy again as secondary raw materials. Waste is thus a valuable raw material that can be used effectively to conserve natural resources. On a global level, over 90% of resources do not reuse in cycle after being disposed. This is not justified considering that there is intensive extraction of limited resources for production and consumption and that in this way waste is increased and waste disposal capacities are reduced [28], [29]. This also leads to different strategies, programs and legal regulations considering and addressing the different aspects of the CE. For example, the Closed Cycle Waste Management Act focusses on waste, recycling and closing material cycles.

The development of circular economy policy in Germany started with implementation of the Waste Disposal Act in 1976 and packaging law in 1991 which required manufacturers to recycle their packaging material and then in following years have been implementation of the "Circular Economy and Waste Management Act" [30].

The circular economy has been recognized throughout the world for protection environments, sustainable management of resources, social networking within and between countries and economic growth without negative ecological and social cost [29]. The circular economy is key to the development of the economy, sustainable development and new jobs, that is, the circular economy is an important element of the development of new technologies, new jobs and increasing the number of jobs, as well as the competitiveness of a country. Comparing the values of sub-indicators between countries allows the comparison of the degree of development of the circular economy between countries, so in this connection further processing of sub-indicators from the field of competitiveness and innovation was started.

Differences among country toward the level of developed circular economy indicate differences of policy in country, shows the differences in policy management for developing awareness of the importance of recycling, waste reduction, resource conservation, through the education system, research and development of innovation for resources circular economy, legal regulations, funding in waste management through public registers of waste producers and equipment and containers for waste disposal, specific materials, etc. The developing activity for improving previous mentioned factors are implicate intensifying and increasing value of gross investment, employment, added value by factor costs, number of patents for climate change mitigation technologies amount of patents/year. On the base of obtained results is evident that in Germany all of those factors are implemented and harmonized in the efficient function and better than in other countries.

For improving circular economy in undeveloped countries is necessary prepare appropriate policy and support companies and stakeholders for integration action in implementation circular economy concept. Also, government need assure financing education of citizens about different topics of circular economy and on this way accelerate awareness, as well as prepare appropriate legislation in all sectors of economy [31]. Innovative thinking and forming partnerships can alleviate some of the waste collection and disposal financial costs and providing a financial incentive for citizens, which can contribute to minimize the number of recyclables in residual waste [32].

The regulation of management resources is organized different on Countries level as well as within a country on regional level, what have important role in the transition and developing circular economy, directed to developing innovative technology in industry production without negative effect on environment, what implicate higher investment in production processes what have social benefits in additional employment arising in chain of recycling [33], [34]. Also, the analysis circular economy innovations showed that they are positively linked to both employment growth and a company's turnover [34] and that about 10% of total waste can save through recycling and according to estimation, the savings in EU material costs would be around 630 billion dollars per year [29]. In this study are established differences of value for analyzed sub-indicators in countries, which is indicate different level of policy for use of resources, production, consumption and recycling [35], [36]. In European countries such as

Germany, the Netherlands, Denmark, Sweden the principles of circular economy implemented on desirable level and that in those countries waste management recognized advantage and lead into developing resource management [37], [38], [39].

Circular economy is a sector with high potential of employment confirmed by data of study [29] which reported that the number of employees in Germany about 200,000 employees in about 3,000 companies which arise for more than 180,000 additional jobs in waste management in Germany up to 2030 year. In Netherlands increased number of companies which reuse material for production [29]. In Serbia and neighbor countries has potential for circular economy development what open great opportunity for employment arise. This is possible achieve with sustainable investments in the public and private sectors, and government and all stakeholders need to create conditions for developing circular economy [40]. In analysis of competitiveness and innovation in the E.U. showed that innovation with other abilities can increase competitive advantage for companies, depending level of innovation and how long it takes the competition to develop an novel equal or sufficient innovation. Also, for sustainable innovation is necessary more governmental support, research, consultancy, and knowledge technological transfer support [41].

In this study the available data on patents (number of patents) is used as an indicator of the innovative activity of a country and allows to assess the development trend of the circular economy. However, only the number of patents is measured here, but not the quality of patents. That is why the OECD (Organizations for Economic Co-operation and Development) is developing indicators - the number of patent families and patent citations - that overcome the problems and shortcomings of traditional indicators. Germany is leader in technical and technologies innovations. This confirmed in studies circular economy in Germany economy [29] which reported that in German developed efficient and low-carbon economy is consistent with the economy growth. So, about 27% of companies in Germany reported innovation in previous decade wherby the most important innovative activity was the reduction of energy use per unit of output [34].

CONCLUSIONS

The movement towards the circular economy is not achieved in one step. It is not a state but a process, so the defined sub-indicators of the circular economy are a very important tool in assessing the development of the circular economy. On the basis of defined sub-indicators we concluded that the circular economy is not equally implemented in the countries, but also that the progress of the circular economy we can monitor the economy of a country over the years through individual sub-indicators. Unlike some countries that are in the initial phase, others are in an advanced stage of circular economy development.

The monitoring the sub-indicators of the circular economy is very important in order to monitor the implementation of CE. The percentage of the implementation of the circular economy is of great importance because the states are given the opportunity to make efforts to improve and improve the sub-indicators by looking at their situation. Also, the circular economy is considered a driver for increased competitiveness, reducing dependence on resources with variable prices and creating new jobs as well as an innovative way of production and consumption.

The measurement system using clearly defined sub-indicators shows that Germany is the leading country in achieving the goals of the circular economy in terms of competitiveness and innovation. The reason certainly lies in the fact that this country has clearly set strategies and goals in achieving the goals of the circular economy.

Improving the circularity of a country contributes to economic growth, and in order to improve circularity, the implementation of circular thinking is necessary at every step. The transformation of the economy towards a circular model is inevitable, and monitoring progress through defined sub-indicators is a prerequisite because the movement towards a circular economy is not achieved in one step, but is a process that requires the use of more modern technology, the emergence of new jobs, a change in the consciousness of all individuals as well as a change in behavioral models and business.

REFERENCES

[1] Geisendorf, S. & Pietrulla, F. (2018). The circular economy and circular economic concepts—a literature analysis and redefinition. *Thunderbird International Business Review*, 60,771-782.

[2] Hoornweg, D. & Bhada-Tata, P. (2012). What a Waste: A Global Review of Solid Waste Management. *World Bank*. Retrieved fromhttps://openknowledge.worldbank.org/bitstream/handle /10986/17388/68135.pdf?sequence=8&isAllowed=y

[3] Hernandez, A., Castillo, H., Ojeda, D., Arras, A., Lopez, J., Sanchez, E., (2010). Effect of vermicompost and compost on lettuce production, Chilean *J. of Agricultural Research*, 70(4), 583-589.

[4] Hangreaves, J.C., Adl, M.S. & Warman, P.R. (2008). A review of the use of composted municipal solid waste in agriculture, Agriculture, *Ecosystems and Environment*, 123, 1-14.

[5] Abd Hamid, A., Ahmad, A., Ibrahim, M., H. & Nik Abdul Rahman, N., (2012). Food waste management in Malaysia – current situation and future management option, *J. of Industrial Research and Technology*, 2(1), 36-39.

[6] Ahmad, R., Jilani, G., Arshad, M., Zahir, Z.A. & Khalid, A. (2007). Bio-conversion of organic wastes for their recycling in agriculture: An overview of perspectives and prospects, Annals of Microbiology, 57(4), 471-479.

[7] Dhokhikah, Y. & Trihadiningrum, Y. (2012). Solid waste management in asian developing countries: Challenges and opportunities, *J. of Applied Environmental and Biological Sciences*, 2(7), 329-335.

[8] Rama, L. & Vasanthy, M. (2014). Market waste management using compost technology, Int. *J. of Plant, Animal &Environmental Sciences*, 4(4), 57-61.

[9] Yang, M., Chen, L., Wang, J., Msigwa, G., Osman, A. I., Fawzy, S., ... & Yap, P. S. (2023). Circular economy strategies for combating climate change and other environmental issues. Environmental Chemistry Letters, 21(1), 55-80.

[10] Rusch, M., Schöggl, J. P. & Baumgartner, R. J. (2023). Application of digital technologies for sustainable product management in a circular economy: A review. *Business Strategy and the Environment*, 32(3), 1159-1174.

[11] Neligan, A., Baumgartner, R. J., Geissdoerfer, M. & Schöggl, J. P. (2023). Circular disruption: Digitalisation as a driver of circular economy business models. *Business Strategy and the Environment*, 32(3), 1175-1188.

[12] Deng, S., Wang, C., Ngo, H. H., Guo, W., You, N., Tang, H., ... & Han, J. (2023). Comparative review on microbial electrochemical technologies for resource recovery from wastewater towards circular economy and carbon neutrality. *Bioresource Technology*, 128906.

[13] Walker, T., Gramlich, D., & Dumont-Bergeron, A. (2020). The case for a plastic tax: a review of its benefits and disadvantages within a circular economy. *Sustainability*, 4, 185-211.

[14] Ferronato, N., Rada, E. C., Portillo, M. A. G., Cioca, L. I., Ragazzi, M.,& Torretta, V. (2019). Introduction of the circular economy within developing regions: A comparative analysis of advantages and opportunities for waste valorization. *Journal of environmental management*, 230, 366-378.

[15] Tóth Szita, K. (2017). The application of life cycle assessment in circular economy. *Hungarian Agricultural Engineering*, 31, 5-9.

[16] Suzanne, E., Absi, N. & Borodin, V. (2020). Towards circular economy in production planning: Challenges and opportunities. *European Journal of Operational Research*, 287(1),168-190.

[17] Ginga, C. P., Ongpeng, J. M. C. & Daly, M. K. M. (2020). Circular economy on construction and demolition waste: A literature review on material recovery and production. Materials, 13(13), 2970.

[18] Zink, T. & Geyer, R. (2017). Circular economy rebound. *Journal of industrial ecology*, 21(3), 593-602.

[19] Haupt, M. & Hellweg, S. (2019). Measuring the environmental sustainability of a circular economy. *Environmental and Sustainability Indicators*, 1, 100005.

[20] Korhonen, J., Honkasalo, A. & Seppälä, J. (2018). Circular economy: the concept and its limitations. *Ecological economics*, 143, 37-46.

[21] Geissdoerfer, M., Savaget, P., Bocken, N. M. & Hultink, E. J. (2017). The Circular Economy–A new sustainability paradigm? *Journal of cleaner production*, 143, 757-768.

[22] Kuzma, E. L., Sehnem, S., Lopes de Sousa Jabbour, A. B., & Campos, L. M. (2022). Circular economy indicators and levels of innovation: an innovative systematic literature review. *International Journal of Productivity and Performance Management,* 71(3), 952-980.

[23] Silvestri, C., Silvestri, L., Piccarozzi, M. & Ruggieri, A. (2022). Toward a framework for selecting indicators of measuring sustainability and circular economy in the agri-food sector: a systematic literature review. *The International Journal of Life Cycle Assessment*, 1-39.

[24] Calzolari, T., Genovese, A. & Brint, A. (2022). Circular Economy indicators for supply chains: A systematic literature review. Environmental and Sustainability Indicators, 13,100160.

[25] Saidani, M., Yannou, B., Leroy, Y., Cluzel, F. & Kendall, A. (2019). A taxonomy of circular economy indicators. *Journal of Cleaner Production*, 207, 542-559.

[26] Nevil, S. & Kindness, D. (2021). How to calculate Z-score and its Meaning, Retrieved 24.12.2022, https://www.investopedia.com/terms/z/zscore.asp

[27] Mitrović, Dj. & Pešalj, B. (2021). *Cirkularna ekonomija – Principi, merenje i implementacija,* Ekonomski fakultet u Beogradu

[28] Blum, U. (2021). Kreislaufführung von Werkstoffen, Komponenten und Produktion: eine ökonomische Herausforderung, Wirtschaftsdienst, 3,186-193.

[29] Wilts, H., Fecke, M. & Zeher, C. (2021). Economics of Waste Prevention: Second-Hand Products in Germany, *Economies*, 9(74), doi: 10.3390/economies9020074.

[30] Mohajan, H.K. (2021). Germany is Ahead to Implement Sustainable Circular Economy, *Journal of Economic Development, Environment and People,* 10(2), 46-64.

[31] Mihajlov, A., Mladenović, A. & Jovanović, F. (2021). Country in trasition (Serbia) case: Circular economy starts from waste management. *Environmental Research &Technology,* 4(1), 83-88.

[32] Ilić, M. & Nikolić, M. (2016). Drivers for development of circular economy e A case study of Serbia. Habitat International, 56,191-200.

[33] D'Amato, D., Droste, N., Allen, B., Kettunen, M., Kähtinen, K., Korhonen, J., Leskinen, P., Matthies, B.D. & Toppinen, A. (2017): Green, circular, bio economy: A comparative analysis of sustainability avenues, *Journal of Cleaner Production*, 168, 716-734.

[34] Horbach, J. & Rammer, C. (2019). Circular economy innovations, growth and employment at the firm level – Empirical evidence from Germany, *Journal of Industrial Ecology*, 24, 615-625.

[35] Yu, C., Davis, C. & Dijkema, G.P.J. (2013). Understanding the Evolution of Industrial Symbiosis Research: A Bibliometric and Network Analysis, *Journal of Industrial Ecology,* 18(2), 280-293.

[36] Avdiushchenko, A. & Zajac, P. (2019). Circular Economy Indicators as a Supporting Tool for European Regional Development Policies, *Sustainability*, 11,3025, doi:10.3390/su/11113025.

[37] Nelles, M., Grünes, J. & Morscheck, G. (2016). Waste Management in Germany – Development to a Sustainable Circular Economy?, Procedia Environmental Sciences, 35, 6-14.

[38] Ogunmakinde, O.E. (2019). A Review of Circular Economy Development Modes in China, Germany and Japan, Recycling, 4(3), doi: 10.3390/recycling4030027

[39] Babri, M., Corvellec, H. & Stål, H.I. (2021). Material affordances in circular products and business model development: for a relational understanding of human and material agency, Culture and Organization, doi: 10.1080/14759551.2021.1986506

[40] Vukadinović, S. & Ješić, J. (2019). Green jobs-potential for employment in the Republic of Serbia. *Anali Ekonomskog fakulteta* u Subotici, 55(41),115-129.

[41] Bucea-Manea-Ţoniş, R., Šević, A., Ilić, M.P., Bucea-Manea-Ţoniş, R., Popović Šević, N. & Mihoreanu, L. (2021). Untapped Aspects of Innovation and Competition within a European Resilient Circular Economy. A Dual Comparative Study. *Sustainability,* 13, 8290. doi.org/10.3390/su13158290

Article history:

Received 23 August 2023

Accepted 25 January 2024