IMCSM Proceedings

ISSN 2620-0597

Volume XX, Issue (2), (2024)

An international serial publication for theory and practice of Management Science

Editor-in-Chief: Prof. dr Marija Panić

Published by University of Belgrade, Technical Faculty in Bor, Department of Engineering Management

Bor, 2024

Scientific Board (SB) of the Conference:

Živan Živković, University of Belgrade, Technical faculty in Bor, **honorary president of SC.**
Marija Panić, University of Belgrade, Technical Faculty in Bor, **president of the SB**.
Predrag Đorđević, University of Belgrade, Technical Faculty in Bor, **vice-president of the SB**.
Aćimović, S., University of Belgrade, Faculty of Economics, Belgrade, Serbia;
Bazen, J., Saxion University of Applied Sciences in Enschede, The Netherlands;
Beh, L.S., University of Malaya, Faculty of Economics and Administration, Kuala Lumpur, Malaysia;
Carrassi, M., University of Bari Aldo Moro, Bari, Italy;
Chelishvili, A., Business and Technology University, Tbilisi, Georgia;
Duysters, G., Eindhoven University of Technology, Eindhoven, The Netherlands;
Filipović, J., University in Belgrade, Faculty of Organizational Science, Belgrade, Serbia;
Gao, S., Edinburgh Napier University, Edinburgh, United Kingdom;
Grošelj, P., University of Ljubljana, Biotechnical faculty, Ljubljana, Slovenia;
Gupte, J., Goa Institute of Management, Poriem, Sattari, Goa, India;
Halis, M., Bolu Abant Izzet Baysal University, Faculty of Communications, Bolu, Turkey;
Huth, M., Fulda University of Applied Sciences, Fulda, Germany;
Kangas, Y., University of Eastern Finland, Joensuu, Kuopio, Eastern Finland, Finland;
Kume, V., University of Tirana, Faculty of Economics, Albania;
Michelberger, P., Obuda University, Budapest, Hungray;
Mitić, P., Institute of Economic Science, Belgrade, Serbia,
Mumford, M. D., University of Oklahoma, Norman, Oklahoma, USA;
Mura, L., University of Ss. Cyril and Methodius, Trnava, Slovakia;
Nikolić, Đ., University of Belgrade, Technical Faculty in Bor, Serbia;
Nordal, A., Municipal Undertaking for Educational Buildings and Property, Oslo, Norway;
Pang, J., Shanxi University, School of Computer and Information Technology, Taiyuan, Shanxi, China;
Parnell, J. A., University of North Carolina Pembroke, School of Business, Pembroke, USA;
Pavlov, D., "Angel Kanchev" University of Ruse, Bulgaria;
Prasad, R., Banaras Hindu University, Institute of Management Studies, India;
Radosavljević, S., Kolubara coal basin, Lazarevac, Serbia;
Radulescu, M., University of Pitiesti, Faculty of Economics, Pitiesti, Romania;
Remeikiene, R., Mykolas Romeris University, Vilinius, Lithuania;
Spasojević Brkić, V., University of Belgrade, Faculty of Mechanical Engineering, Belgrade, Serbia;
Stefanović, D., University of Novi Sad, Faculty of Technical Sciences, Novi Sad, Serbia;
Stevic, Ž., University of East Sarajevo, Faculty of Transport and Traffic Engineering, Doboj, Bosnia and Herzegovina;
Szarucki, M., Cracow University of Economics, Cracow, Poland;
Ingram, T., University of Economics in Katowice, Katowice, Poland;
Usman, B., University of Bengkulu, Faculty of Economics and Business, Bengkulu, Indonesia;
Virglerová, Z., Tomas Bata University in Zlín, Center for Applied Economic Research, Zlin, Czech Republic;
Zwikael, O., The Australian National University, Research School of Management, Canberra, Australia;

Organizing Board of the Conference:

Fedajev, A., president of the Organizational Board;
Panić, M., vice-president of the Organizational Board;
Voza, D., vice-president of the Organizational Board;
Veličković, M., member of the Organizational Board;
Arsić, S., member of the Organizational Board;
Gajić, M., member of the Organizational Board;
Jevtić, A., member of the Organizational Board;
Radić, A., member of the Organizational Board;
Vasković, S., member of the Organizational Board.

Editorial board:

Marija Panić, Editor in Chief;
Aleksandra Fedajev, Co-Editor;
Danijela Voza, Co-Editor;
Milica Veličković, Technical Editor;
Sanela Arsić, Technical Editor;
Sandra Vasković, Technical Co-Editor;
Adrijana Jevtić, Technical Co-Editor;
Aleksandra Radić, Technical Co-Editor.

Reviewers:

Živan Živković, University of Belgrade, Technical faculty in Bor;
Marija Panić, University of Belgrade, Technical Faculty in Bor;
Predrag Đorđević, University of Belgrade, Technical Faculty in Bor;
Aćimović, S., University of Belgrade, Faculty of Economics, Belgrade, Serbia;
Bazen, J., Saxion University of Applied Sciences in Enschede, The Netherlands;
Beh, L.S., University of Malaya, Faculty of Economics and Administration, Kuala Lumpur, Malaysia;
Carrassi, M., University of Bari Aldo Moro, Bari, Italy;
Chelishvili, A., Business and Technology University, Tbilisi, Georgia;
Duysters, G., Eindhoven University of Technology, Eindhoven, The Netherlands;
Filipović, J., University in Belgrade, Faculty of Organizational Science, Belgrade, Serbia;
Gao, S., Edinburgh Napier University, Edinburgh, United Kingdom;
Grošelj, P., University of Ljubljana, Biotechnical faculty, Ljubljana, Slovenia;
Gupte, J., Goa Institute of Management, Poriem, Sattari, Goa, India;
Halis, M., Bolu Abant Izzet Baysal University, Faculty of Communications, Bolu, Turkey;
Huth, M., Fulda University of Applied Sciences, Fulda, Germany;
Kangas, Y., University of Eastern Finland, Joensuu, Kuopio, Eastern Finland, Finland;
Kume, V., University of Tirana, Faculty of Economics, Albania;
Michelberger, P., Obuda University, Budapest, Hungray;
Mitić, P., Institute of Economic Science, Belgrade, Serbia,
Mumford, M. D., University of Oklahoma, Norman, Oklahoma, USA;
Mura, L., University of Ss. Cyril and Methodius, Trnava, Slovakia;

Scientific Council:

CIP - Каталогизација у публикацији
Народна библиотека Србије, Београд

005.51(082)(0.034.2)

INTERNATIONAL May Conference on Strategic Management (20 ; 2024 ; Bor)
[XX] International May Conference on Strategic Management – IMCSM24, May 31, 2024, Bor [Elektronski izvor] / [editor in chief Marija Panić]. - Bor : University of Belgrade, Technical Faculty, Engineering Management Department, 2024 (Bor : Tercija). - 1 USB fleš memorija ; 1 x 2 x 6 cm. - (IMCSM Proceedings, ISSN 2620-0597 ; vol. 20, issue (2) (2024))

Sistemski zahtevi: Nisu navedeni. - Nasl. sa naslovne strane dokumenta. - Tiraž 100. - Bibliografija uz svaki rad.

ISBN 978-86-6305-151-5

а) Стратешки менаџмент -- Зборници

COBISS.SR-ID 145961993

Conference is financially supported by the Ministry of Science, Technological development and Innovation of the Republic of Serbia

Konferencija je finansijski podržana od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije

Gold Donor

INTERNATIONAL MAY CONFERENCE ON STRATEGIC MANAGEMENT

SADRŽAJ

Volume XX, Issue (2) (2024) 180-190

International May Conference on Strategic Management

DOI: *10.5937/IMCSM24069N*

Original research

ANALYSIS OF INNOVATION IN EU COUNTRIES

Ivica Nikolić*, Anđelka Stojanović, Aleksandra Radić, Predrag Đorđević

University of Belgrade, Technical Faculty in Bor, Serbia

Abstract: This paper explores the level of innovativeness among European Union (EU) countries through the application of the Global Innovation Index (GII) and cluster analysis methodology. The research aims to identify the key factors contributing to innovation in various EU countries and to group these countries into homogeneous cluster groups to understand their innovation performance better. Cluster analysis is employed to identify similarities among countries based on their innovation characteristics. The research results provide insight into the relative position of EU countries in the domain of innovation, identifying innovation leaders as well as those lagging behind. Cluster analysis enables the grouping of countries into cluster groups based on similarities in their innovation profiles, facilitating the identification of common challenges and opportunities for collaboration.

Keywords: Global Innovation Index, Innovation, European Union, Cluster analysis

1. INTRODUCTION

Understanding the concept of innovation represents an extremely important prerequisite for further comprehension of this research. The term "innovation" is notoriously difficult to define. It represents a highly complex concept and can be defined through various aspects. The word "innovation" is used in numerous spheres today, and depending on the context, it can have various meanings. For this reason, numerous definitions exist that delineate this term. Since this research focuses on studying innovation in European Union countries, we will adopt the definition found on the European Commission website. "Innovation can be defined as the development or adoption of new concepts or ideas, and/or the new or adopted ideas themselves, as well as the successful exploitation of new ideas. Creativity has the ideas, and innovation is its application. Creativity only emerges when the innovator takes the idea and does something with it. Successful exploitation of new ideas can lead to increased organizational or social benefit." (European Commission, 2014)

Innovation is a pivotal factor influencing economic growth, competitiveness, and societal sustainability in the contemporary world (Schumpeter, 1934; Porter, 1990). The

* *Corresponding author: inikolic@tfbor.bg.ac.rs*

Ivica Nikolić, ORCID: 0000-0003-1986-4653
Anđelka Stojanović, ORCID: 0000-0001-7254-4646
Aleksandra Radić, ORCID: 0000-0003-4253-8004
Predrag Đorđević, ORCID: 0000-0002-8210-174X

process of globalization necessitates that national innovation systems continually adapt to the demands of the global market (Petkovski, 2023). Contemporary literature has already identified a positive coherence between globalization's economic, political, and social effects and technological innovation performance (Feng et al., 2019; Zheng et al., 2019). Accordingly, analyzing the level of innovativeness in European Union (EU) countries becomes crucial for understanding its economic and social development. The Global Innovation Index (GII) provides a comprehensive methodology for measuring innovation on a global scale, encompassing a wide range of indicators reflecting countries' innovation capacities (WIPO, 2023). Additionally, cluster analysis is a powerful tool enabling the grouping of countries into homogeneous clusters based on the similarity of their innovation characteristics (Everitt et al., 2011). The combination of GII and cluster analysis offers deeper insights into the innovative performance of EU countries and identifies key factors contributing to their innovativeness. This paper aims to explore the application of GII and cluster analysis in analyzing innovation in EU countries. Cluster analysis is expected to reveal which EU countries excel in innovation and which lag behind, thus grouping them according to similarities in their innovation profiles, which aids in addressing common problems and opportunities for mutual collaboration. Firstly, we will provide an overview of relevant literature on innovation and methods of measurement. Then, we will examine EU countries and their positioning based on GII. Subsequently, we will present the methodology to be used in the research, including a description of GII and cluster analysis. Following that, we will analyze the research results, identifying key innovation factors in EU countries and grouping them into homogeneous cluster groups. We will discuss the implications of the obtained results and opportunities for policies aimed at enhancing innovation in the region. Finally, we will present conclusions and recommendations for further research and actions in the field of innovation in EU countries. This study contributes to the theoretical and practical understanding of innovation in the EU and provides a basis for developing effective policies and strategies for enhancing innovation and economic development.

2. LITERATURE REVIEW

Innovation is considered a primary driver of economic development and competitive advantage. Hence, governments worldwide are responsible for implementing appropriate measures to enhance national innovative performance (Wonglimpiyara, 2010). Subsequent research studies provide valuable contributions to explaining the developmental trajectory of innovation performance in EU countries. In a study conducted by Skare et al., (2023), the authors quantified the relationships between innovation activities and e-commerce outcomes in the European Union, with the Global Innovation Index (GII) included as one of the parameters. Dachs et al., (2019) investigated the impact of mixed innovation policies on national systems' performance, utilizing European Union countries' data. Although there are studies that have considered the influence and significance of GII, they have not specifically focused on European Union countries. Petkovski (2023) attempted to construct a structural model of the innovative environment based on GII. Similarly, in a study by Ćosić et al. (2023), GII was analyzed in Serbia and Bosnia and Herzegovina. Additionally, in the research conducted by Stojanović et al. (2023), GII was used as a parameter to examine the impact of environmental taxation on ecological innovations in European Union countries as well as other European countries. It is noteworthy that there is currently no research in the academic literature analyzing the impact of innovativeness using the Global Innovation Index in European Union countries.

There is currently a lack of studies utilizing the Global Innovation Index (GII) within the EU and cluster analysis for exploring innovativeness. This highlights a deficiency in an

integrated approach combining these two methodologies for assessing innovation within the EU. Cluster analysis could provide deeper insights into regional patterns of innovation within the EU, while the GII could offer a global perspective and facilitate comparative analyses between EU countries and other parts of the world. Integrating these approaches could be beneficial for the development of targeted innovation policies at the EU and its member state levels. However, future research in this area would be crucial for a deeper understanding of the factors influencing innovation in the EU and the identification of the most effective innovation support strategies.

3. GLOBAL INNOVATION INDEX IN EU COUNTRIES

The Global Innovation Index (GII) represents a pivotal tool for measuring innovation at a global scale (WIPO, 2023). Within the European Union (EU) context, the GII provides valuable insights into the innovative capacities of its member states (European Commission, 2024). Analysis of GII results enables the identification of key factors influencing innovation in EU countries (Fagerberg et al., 2009). Studies have indicated that EU countries with higher rankings on the GII often exhibit greater economic growth and competitiveness rates. Consequently, innovation management in EU countries is increasingly focused on enhancing outcomes measurable through the GII. Additionally, the GII can be useful for assessing the effectiveness of innovation policies and fostering political dialogue among EU countries (Lopez-Claros & Mata, 2005; Bjørnåli & Mathisen, 2015).

3.1. The European Union

The European Union consists of 27 countries located in Europe. These nations united with the goal of improving the quality of life, streamlining convenience, and guaranteeing the safety of their citizens. To achieve these objectives, they pledged to work together collaboratively and provide mutual support. Member states of the European Union are depicted in Figure 1 (European Commission, 2024).

Figure 1. Member States of the European Union (European Commission, 2024).

The European Union (EU) emerged from the aspiration of nations to collaborate, driven by the aftermath of two major wars that ravaged Europe. Recognizing the negative consequences of conflict, European countries concluded that fostering cooperation outweighed fostering discord. Thus, the genesis of the European Union is deeply embedded in the pursuit of a more tranquil and prosperous future, wherein collective endeavours take precedence over division. Initially, a coalition of six European countries embarked on collaborative efforts (Belgium, France, Germany, Italy, Luxembourg, and the Netherlands). Subsequently, other European nations joined, culminating in the establishment of the European Union. Presently, the European Union encompasses 27 countries: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden. In June 2016, the United Kingdom decided to withdraw from the European Union. Consequently, as of January 31, 2020, the United Kingdom ceased to be a member of the European Union (European Commission, 2024).

The European Union (EU) stands as a prominent global player in the realm of innovation, persistently endeavouring to bolster competitiveness and economic growth through innovative practices. Innovation has evolved into a pivotal facet of European policy geared towards cultivating a dynamic, sustainable, and inclusive economic framework. EU innovation policy is centred around fostering research and development, nurturing entrepreneurship, and fostering an environment conducive to innovation. Despite concerted efforts, the EU grapples with several challenges in the innovation sphere. Among these challenges are inadequate investments in research and development, market fragmentation, a dearth of entrepreneurial zeal, and sluggishness in the transference of innovations from academic circles to industry.

3.2. The Global Innovation Index (GII)

The Global Innovation Index (GII) was established by the World Intellectual Property Organization (WIPO) with the objective of systematically reporting on the most significant trends in global innovation and ranking each considered country based on its innovative performance on a global ranking list. The GII report is published annually by INSEAD Cornell University in collaboration with WIPO since 2007. The graphical representation of the GII conceptual framework provided in Figure 2 is utilized to provide insight into the relationship established between dimensions. Calculating the GII score is a complex procedure as it takes into account various dimensions and components. Each of the GII components represents an index measured by the World Bank, UNESCO, or other relevant institutions, presented in the form of quantitative data, qualitative data, or composite indicators data (determined as the weighted average of each component). Components are then normalized on a scale from 0 to 100 using the min-max method to enable the ranking procedure. Ranking lists are available for the overall GII and for each dimension and component.

In a world of increasing competition, many countries compete to enhance their innovative capabilities with the aim of achieving growth and economic performance. Competition and innovation are crucial for countries to strengthen their innovative abilities, as they provide potential avenues for accelerating the process of technological catch-up and maintaining productivity and competitive growth. These facts are also valid for European Union countries. Displaying the innovation index can assist the economies of European Union countries in the catch-up process, as it provides overall innovation performances of countries. The innovation index could also aid in assessing what a country should do to stimulate innovation, resulting in economic growth and employment. Furthermore, the innovation index highlights policy challenges—national policies for the development of new national innovation

strategies. The Global Innovation Index (GII) is an evolving project that builds upon its previous editions, incorporating newly available data and inspired by the latest research on innovation measurement. The research we are conducting is based on data from 2023, and the GII model encompasses 132 countries/economies, relying on two sub-indices: Innovation Input and Innovation Output. Each is constructed around pillars.

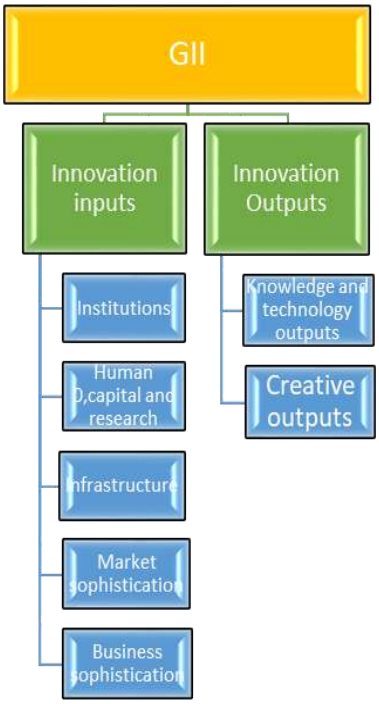

Figure 2. GII Dimensions

The description of dimensions in the structure of the Global Innovation Index (GII) for 2023 is outlined below, derived from the official GII report:

Institution Dimension: This dimension encompasses the political, regulatory, and business environment within a country.

Human Capital and Research Dimension: This dimension focuses on the educational perspective, incorporating education expenditures, the number of students, and education duration into its measurement.

Infrastructure Dimension: This dimension comprises three components, including information and communication technology (ICT) access and use, general infrastructure, and ecological sustainability. General infrastructure includes electricity output, logistic performances, and gross capital formation.

Market Sophistication Dimension: This dimension encompasses aspects such as credits, investments, trade, and competition scale.

Business Sophistication Dimension: This dimension emphasizes the knowledge perspective of innovation. It includes factors such as knowledge workers, innovation linkages, and knowledge absorption. This dimension considers the number of knowledge workers, employee access to formal training, collaboration between universities and industry in innovation, and technology imports.

Knowledge and Technology Outputs Dimension: This dimension comprises measurements related to knowledge creation, knowledge impact, and knowledge diffusion. Knowledge creation is reflected in the number of patents and research articles. Knowledge

impact considers factors such as GDP growth rate per engaged person, firm density, and computer software spending. Knowledge diffusion assesses financial resources for license fees for intangible assets, technology exports, and investments abroad.

Creative Outputs Dimension: This dimension consists of three components: intangible assets, creative goods and services, and online creativity. Intangible assets are measured by the number of issued trademarks and the influence of ICT on business and organizational model creation. Creative goods and services measure the cultural environment reflected in expenses for recreation and culture, produced films and newspapers, and exported creative goods and services. Online creativity is evaluated through country code domains, Wikipedia editors, and mobile app creation.

4. DATA AND METHODOLOGY

The introduction of cluster analysis as a methodology in investigating innovation in European Union countries represents a significant step towards a deeper understanding of the complex interactions within innovation systems. Cluster analysis offers the possibility of grouping similar entities based on their characteristics, enabling the identification of key patterns and trends in innovative activities. This methodology has proven useful in studying regional differences in innovation, identifying key sectors with high potential for development, and formulating targeted innovation support policies at the local level. The application of cluster analysis in EU countries provides an opportunity for a better understanding the specificities of innovation systems within different member states, as well as identifying common challenges and opportunities for enhancing innovation at the Union level. This introductory text highlights the importance of cluster analysis as a methodology that contributes to the more efficient development of innovation policies and strengthens the competitiveness of EU countries in the global context.

Grouping is performed based on the results (scores) calculated based on the values of attributes across all variables for each observation unit separately. The method used for classification must be entirely numerical, and the number of classes is usually not known in advance. There are many reasons for using cluster analysis. In our research, the values of seven dimensions of the Global Innovation Index for the year 2023 in European Union countries were taken as variables. This study aimed to identify key patterns and groupings of countries based on their innovation characteristics in order to understand better the structure and dynamics of innovation systems in the EU. Through the analysis of seven dimensions of the GII, such as human capital, research and development, infrastructure, market, business environment, knowledge creation, and technology outputs, a comprehensive insight into the innovation performance of EU countries was sought. The results of this research should provide a basis for formulating targeted innovation policies at the Union level, as well as identifying areas where capacity strengthening is needed to enhance competitiveness and sustainable economic growth in Europe. Data for analysis are presented in Table 1.

The countries of the European Union listed in Table 1 are ranked according to the GII for 2023. It is evident that the top three ranked countries are Sweden, Finland, and the Netherlands, while the bottom three ranked countries are Croatia, Slovakia, and Romania. This ranking comes as no surprise. The top three ranked countries, according to the Global Innovation Index (GII), Sweden, Finland, and the Netherlands, are often recognized as leaders in innovation and the development of high-tech sectors. Sweden, with its strong focus on research and development, along with its advanced educational system, serves as an example of exceptional innovation and technological advancement. Finland, known for its ability to foster innovative startups and support entrepreneurship, also stands out as a leader in

innovation. Similarly, the Netherlands, with its open and dynamic economy, along with high levels of investment in research and development, also positions itself highly on the GII list. On the other hand, the three lowest-ranked countries, Croatia, Slovakia, and Romania, face challenges in developing innovative capacity and technological competitiveness. This ranking is unsurprising, given insufficient investments in research and development, lack of innovation-supporting infrastructure, and business environment obstacles hindering innovative enterprises' development. The three worst-ranked countries, Croatia, Slovakia, and Romania share a common historical point of being former communist countries. Although these countries have since undergone transformation, leaving behind the communist regime, they still face challenges in developing innovative capacity and technological competitiveness.

Table 1. Data for analysis (WIPO, 2023)

No.	Country	Overall GII	Institutions	Human capital and research	Infrastructure	Market sophistication	Business sophistication	Knowledge and technology outputs	Creative outputs
1	Sweden	2	18	3	2	10	1	3	8
2	Finland	6	3	5	1	12	4	4	16
3	Netherlands	7	6	13	14	15	8	8	9
4	Germany	8	22	4	23	14	16	9	7
5	Denmark	9	5	9	3	21	12	12	10
6	France	11	27	17	22	9	17	16	6
7	Estonia	16	11	34	5	5	25	20	15
8	Austria	18	13	11	12	39	19	17	13
9	Luxembourg	21	7	31	31	35	7	38	11
10	Ireland	22	15	28	18	51	14	14	26
11	Belgium	23	30	14	44	26	10	15	30
12	Malta	25	34	39	17	43	21	36	4
13	Italy	26	52	33	21	40	33	18	21
14	Republic of Cyprus	28	41	38	32	38	31	23	17
15	Spain	29	46	27	16	33	32	24	29
16	Portugal	30	35	23	45	42	34	32	19
17	Czech Republic	31	36	30	24	82	27	21	32
18	Slovenia	33	38	25	20	68	26	27	48
19	Lithuania	34	19	42	43	34	35	29	41
20	Hungary	35	47	36	42	64	30	26	38
21	Latvia	37	39	43	33	61	37	49	31
22	Bulgaria	38	66	66	28	60	42	34	34
23	Poland	41	76	40	47	67	41	40	35
24	Greece	42	63	29	38	66	62	43	39
25	Croatia	44	72	44	26	48	53	33	52
26	Slovakia	45	65	53	41	72	47	31	56
27	Romania	47	74	75	34	75	51	35	58

During the communist era, the focus was on a centralized economy and limited market access, which hindered innovation and entrepreneurship development. Although things have changed since then, the transition to a market economy and open society requires time and effort. These countries are challenged with adapting to new economic models and establishing a conducive environment for innovation while simultaneously grappling with inherited structural and institutional barriers.

The number of groups or clusters to expect based on the formed sample is often not known in advance. To determine the optimal number of clusters, a two-step analysis is typically conducted:

In the first step, hierarchical cluster analysis is conducted using Ward's method. This determines the optimal number of clusters for further investigation.

In the second step, hierarchical cluster analysis, with the selected number of clusters, is conducted again, allowing each respondent (observation) to be assigned to a cluster.

This clustering methodology is implemented using the SPSS software package.

5. RESULTS AND DISCUSSION

The results commence with Table 2, which illustrates solutions for each possible number of clusters from 1 to 27 (the total number of EU countries).

Table 2. Agglomeration Schedule

Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	3	5	103.500	0	0	7
2	13	15	227.000	0	0	5
3	4	6	362.500	0	0	17
4	1	2	516.500	0	0	7
5	13	14	771.667	2	0	22
6	17	18	1 038.667	0	0	16
7	1	3	1 315.417	4	1	20
8	26	27	1 644.917	0	0	15
9	8	10	1 982.917	0	0	19
10	20	21	2 397.917	0	0	16
11	23	24	2 816.917	0	0	21
12	22	25	3 373.917	0	0	15
13	16	19	3 963.417	0	0	18
14	9	12	4 614.417	0	0	19
15	22	26	5 384.667	12	8	21
16	17	20	6 222.667	6	10	24
17	4	7	7 078.500	3	0	20
18	11	16	7 969.000	0	13	22
19	8	9	8 981.000	9	14	23
20	1	4	10 121.702	7	17	25
21	22	23	11 435.452	15	11	26
22	11	13	12 831.286	18	5	23
23	8	11	15 235.286	19	22	24
24	8	17	19 301.286	23	16	25
25	1	8	32 858.262	20	24	26
26	1	22	57 714.444	25	21	0

In Table 2, the crucial column is the Coefficients column, which presents the calculated agglomeration coefficients for specific cluster numbers. Thus, proceeding from the end towards the beginning of the column, we observe that for one cluster, the coefficient is 57,714.444; for two clusters, it is 32,858.262; for three clusters, it is 19,301.286, and so forth. A sharp decrease in the coefficient of agglomeration change (4th column) is noted between solutions with 3 and 4 clusters (decreasing from 32,858.262 to 19,301.286). The last column, with the values of coefficient change, allows us to determine the optimal number of clusters. In this case, it is 3 clusters. The dendrogram in Figure 3 can also aid in determining the number of clusters.

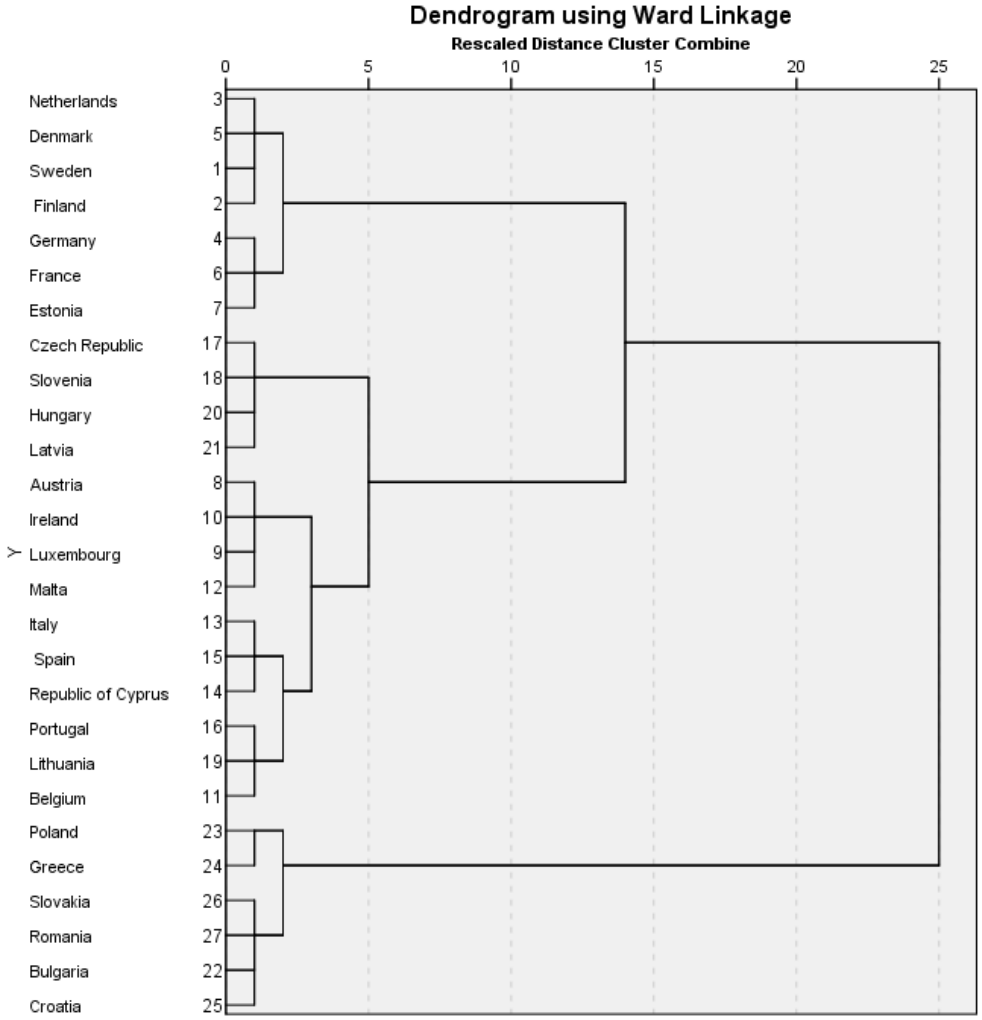

Figure 3. Dendrogram for determining the number of clusters

From the obtained dendrogram, the existence of two major clusters and one minor cluster can be discerned, confirming that the optimal number of clusters is 3.

Now, we can proceed to repeat the hierarchical cluster analysis, specifying the program to assign each observation to one of the three chosen clusters. Consequently, it becomes apparent that seven countries (Netherlands, Denmark, Sweden, Finland, Germany, France, Estonia) are classified into cluster 1, fourteen countries (Czech Republic, Slovenia, Hungary, Latvia, Austria, Ireland, Luxembourg, Malta, Italy, Spain, Republic of Cyprus, Portugal, Lithuania, Belgium) into cluster 2, and six countries (Poland, Greece, Slovakia, Romania, Bulgaria, Croatia) into cluster 3. The grouping of Poland into cluster three alongside countries of former communist regimes is surprising.

6. CONCLUSION

Innovation represents a crucial driver of progress for every nation. The level of competitiveness among nations regarding innovation is precisely expressed through the Global Innovation Index (GII). GII reports encompass over 130 countries worldwide and, based on numerous parameters, indicate how innovatively competitive a country is. Among the most competitive nations globally, we find the European Union member states. However, even among them, there are certain disparities concerning innovation. Based on these differences, through the application of cluster analysis, it has been determined that they can be grouped into three clusters. The first cluster comprises Western European countries, the founding members of the European Union, while the second, the largest group, consists of later entrants to the European Union. The third cluster comprises Balkan countries that joined the European Union later, constituting the class of least innovative-capable nations. These countries should identify common challenges and opportunities for collaboration to enhance innovative performances. This entails increasing investments in research and development, building infrastructure to support innovation, reducing bureaucratic barriers and corruption, improving the educational system, and promoting entrepreneurship and innovation.

ACKNOWLEDGMENT

The research presented in this paper was done with the financial support of the Ministry of Science, Technological development and Innovation of the Republic of Serbia, within the funding of the scientific research work at the University of Belgrade, Technical Faculty in Bor, according to the contract with registration number 451-03-65/2024-03/200131.

REFERENCES

Bjørnåli, E. S., & Mathisen, T. A. (2015). Innovation Performance: State of the Art. Nova Science Publishers.

Ćosić, M., Tomić, L., & Mesarević, A. (2023). The analysis of the Global Index of Innovation of Serbia and Bosnia and Herzegovina. *Trendovi u poslovanju*, XI(21), 84–90. https://doi.org/10.5937/trendpos2301084C (In Serbian)

Dachs, B., Ebersberger, B., & Borowiecki, M. (2019). The Impact of Innovation Policy Mixes on the Performance of the National Innovation System. *Research Policy*, 48(7), 103708. https://doi.org/10.1016/j.technovation.2012.06.002

European Commission. (2014). European Commission. Retrieved from https://ec.europa.eu/enrd/enrd-static/leader/leader/leader-tool-kit/the-strategy-design-and-implementation/the-strategy-design/en/what-is-innovation_en.html

European Commission. (2024). European Commission. Retrieved from https://commission.europa.eu/index_en

Everitt, B., Landau, S., & Leese, M. (2011). Cluster Analysis. John Wiley & Sons.

Fagerberg, J., Mowery, D. C., & Verspagen, B. (2009). Innovation Systems: Analyzing the Dynamics of Technology. Oxford University Press.

Feng, G. F., Zheng, M., Wen, J., Chang, C. P., & Chen, Y. E. (2019). The assessment of globalization on innovation in Chinese manufacturing firms. *Structural Change and Economic Dynamics*, 50, 190–202. https://doi.org/10.1016/j.strueco.2019.06.012

Lopez-Claros, A., & Mata, F. (2005). Global Competitiveness Report 2005-2006. World Economic Forum. Retrieved from https://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2006-07.pdf

Petkovski, I. (2023). Structural PCA-MLR model of the innovation environment in BRICS countries. *Serbian Journal of Management*, 18(1), 1–26. https://doi.org/10.5937/sjm18-32136

Porter, M. E. (1990). The Competitive Advantage of Nations. Harvard Business Review Press.

Schumpeter, J. A. (1934). The Theory of Economic Development. Harvard University Press.

Skare, M., Gavurova, B., & Rigelsky, M. (2023). Innovation activity and the outcomes of B2C, B2B, and B2G E-Commerce in EU countries. *Journal of Business Research*, 163, 113874. https://doi.org/10.1016/j.jbusres.2023.113874

Stojanović, M., Gligorijević, J., Stojanović, G., & Becić, S. (2023). Analysis of the impact of environmental taxation on environmental innovations. *Ekonomija teorija i praksa*, XVI(1), 101–119. https://doi.org/10.5937/etp2301101S (in Serbian)

WIPO. (2023). Global Innovation Index 2023. Retrieved from https://www.wipo.int/global_innovation_index/en/2023/

Wonglimpiyarat, J. (2010). Innovation index and the innovative capacity of nations. Futures, 42(3), 247–253. https://doi.org/10.1016/j.futures.2009.11.010

Zheng, M., Feng, G. F., Feng, S., & Yuan, X. (2019). The road to innovation vs. the role of globalization: A dynamic quantile investigation. Economic Modelling, 83, 65–83. https://doi.org/10.1016/j.econmod.2019.09.019