ENTREPRENEURSHIP AND SUSTAINABILITY ISSUES
ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 11 Number 4 (June)
http://doi.org/10.9770/jesi.2024.11.4(18)

Publisher
http://jssidoi.org/esc/home

INNOVATION PERFORMANCE OF V4 COUNTRIES*

Denisa Hanáčková [1], Ivan Takáč [2]

[1,2] Slovak Agricultural University, Tr. A. Hlinku 2, 949 76 Nitra

E-mails:[1] denisa.hanackova@uniag.sk; [2] ivan.takac@uniag.sk

Received 11 January 2024; accepted 30 April 2024; published 30 June 2024

Abstract. This study delves into the innovation performance of the Visegrad Four (V4) countries, aiming to uncover the pivotal role that research development and innovation play in regional development and the broader economic landscape. Focusing on properly structured research and development policies, financial support mechanisms, and collaborative efforts, we investigate the prerequisites for fostering innovative activities within these nations. Innovation performance is a critical factor that allows organisations and economies to adapt to rapid changes and an ever-evolving environment, stimulating growth, competitiveness, and long-term sustainability. The goal of the article was to evaluate the innovation performance of the V4 countries. Utilising the TOPSIS method, we analyse 7 key input-output indicators to rank the V4 countries in terms of their innovation performance for 2022, identifying them as moderate innovators relative to the EU-27 average. Our findings reveal that among the V4, the Czech Republic leads in innovation performance, followed by Slovakia, Poland, and Hungary, respectively. The analysis underscores the importance of innovation as a critical factor for adaptation to rapid changes, fostering growth, competitiveness, and sustainability. This research contributes to understanding how innovation performance can improve economic prosperity in the V4 countries and inform policy direction towards enhancing innovation ecosystems.

Keywords: innovation performance; research and development (R&D); competitiveness; V4 Countries; TOPSIS method

Reference to this paper should be made as follows: Hanáčková, D., Takáč, I. 2024. Innovation performance of V4 countries. *Entrepreneurship and Sustainability Issues*, 11(4), 293-310. http://doi.org/10.9770/jesi.2024.11.4(18)

JEL Classifications: O11, O31, O38

1. Introduction

In the contemporary economic landscape, innovation, science, research, and development (R&D) stand as critical pillars of progress and prosperity. These elements drive the advancement and competitiveness of various sectors and underpin nations' economic growth (Dušek & Sagapova, 2022; Androniceanu, Georgescu & Sabie, 2022). However, the current conditions lead firms to collaborate for innovation activities rather than taking individualistic initiatives (Rigelsky et al., 2022). For this reason, policymakers, including the European Union, direct businesses to make joint investments in innovation activities. Alliances between enterprises also make them apply more R&D activities, improving innovation capabilities (Ključnikov et al., 2022a) that provide financial sustainability. Since many issues exist in the economic growth and deterioration of resources, the sustainability concept needs to be considered by everyone worldwide (Folgado-Fernández et al., 2023), including firms from different industries (Cheng et al., 2022). European Commission also implements new

* *This research was funded by the Scientific Grant Agency of the MoESRS and the Slovak Academy of Sciences under contract No. VEGA-1/0437/22*

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 11 Number 4 (June)
http://doi.org/10.9770/jesi.2024.11.4(18)

strategies to stimulate firms in various industries to adopt a digital transformation process that increases and sustainable development of businesses (Streimikiene, 2023).

Moreover, this digitalisation process increases technological productivity (Lincényi & Bulanda, 2023) and the competitiveness of enterprises (Krajčík et al., 2023). Through the lens of innovation and technological evolution, industries are born and transformed; productivity is enhanced. For instance, firms, especially in the manufacturing industry, indicate more technological developments and emphasise innovation and R&D activities (Civelek & Krajčík, 2022). Therefore, both economic and social development are accelerated. In this context, the innovative performance of a country is intricately linked not only to the capabilities of its firms but also to the broader national system, encompassing a network of public and private institutions. This study, therefore, seeks to illuminate the significance and topicality of innovation in shaping regional development and the economic performance of the national economy. Specifically, we focus on the Visegrad Four (V4) countries to evaluate their innovation performance within a comparative framework. Recognising the essential role that properly structured R&D policies, financial support mechanisms, and collaborative efforts play in fostering innovation, this article delves into the dynamics of innovation within the V4. By exploring these aspects, we aim to contribute to the broader understanding of how innovation is a lever for economic prosperity and sustainability. As such, our analysis seeks not only to assess the current state of innovation performance in these countries but also to offer insights that may guide policy direction and support mechanisms to enhance their innovation ecosystems.

2. Theoretical background

The relationship between research, development, and innovation is highly complex. It's essential to recognise that innovations cannot arise without adequate research and development (Wach & Daszkiewicz, 2023). Innovations are interpreted as a process in which organisations do something new, introduce novel procedures, create new goods or services (Khalifa et al., 2023), or establish new ways of internal organisational relationships. Hanáčková et al. (2019) further clarify that innovation should not be confused with the concept of change, as change is typical for most organisations; innovations pertain to creating and implementing new processes, products, services, and delivery methods. Typically, innovations improve outputs, efficiency, effectiveness, or the quality of goods, services, and processes (Espino-Rodríguez et al., 2022). Innovation involves qualitative and sustainable change. Therefore, the following criteria can also apply to identifying innovations: novelty or creativity, efficiency - focus on results, the significance of the problem being addressed, and applicability (Staroňová et al., 2012).

Effective economic and social development (predicated on innovation) is an indispensable condition for mitigating disparities between impoverished and affluent regions (Ključnikov et al., 2022b). Development that is fundamentally anchored in research, development, and innovations plays a pivotal role in regional development and in enhancing the performance of national economies. This becomes increasingly vital in escalating global competition, heightened population mobility, swift technological advancements, and the emergence of spatial disparities and imbalances. Moreover, it is essential for the strategic distribution of companies, which in turn augments local employment opportunities. Giguère (2007) argues that the ever-widening regional disparities are the result of the fact that investments are directed mainly to large agglomerations with developed infrastructure and a skilled workforce, while other regions are still lagging behind. The ability to produce innovations and new economic activities is essential for developing local economies and, thus, improving the living standards of the local population. Strong knowledge and technologically advanced regions can benefit from better opportunities for networking and relations with foreign 'partners so that they have a leading position within the country.

On the contrary, in less developed regions and peripheral areas, the low ability to produce new ideas and inappropriately directed policies can be reflected in the widening knowledge and technological gap between regions (Maguire et al., 2011). The introduction and dissemination of innovations are important for overall increases in private sector investments, improving the flow of information, focusing on content and methods of research as well as relationships with investors or developers, and promoting cohesion and trust (Clark, Huxley,

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 11 Number 4 (June)
http://doi.org/10.9770/jesi.2024.11.4(18)

Mountford, 2010; Maturkanič et al., 2022; Lacko et al., 2023; Mishchuk et al., 2023; Zhang et al., 2023). Innovations typically emerge in environments with a sufficient foundation of human and physical capital. The effect of such innovations is the creation of a dynamic economy, which, in turn, attracts additional human resources and capital (Oliinyk et al., 2021; Floriš et al., 2022; Masárová & Ivanová, 2023;). Therefore, according to the theory of endogenous growth, innovations and human capital tend to be located in relatively the same geographical areas. The endogenous growth model fully incorporates the view of innovations as the result of planned efforts and sheds new light on innovations' contribution towards understanding dynamic growth (Crescenzi & Rodríguez-Pose, 2011; Tadevosyan, 2023). The action dynamics is present in innovation (Kondrla et al., 2023). Cheah (2016) also emphasises the importance of quantifying the economic consequences of innovations, asserting that with substantial investments in research and development intended to bring changes in both the private and public sectors, it is essential for policymakers to be able to implement logical tools and procedures when estimating economic impacts.

The interaction between R&D actors and the knowledge economy, foundational for innovations, is represented by the triple helix model that connects the academic, public, and private sectors. The private nonprofit sector complements the trio of innovation actors in R&D. Key players in the development of R&D primarily include enterprises (Zsigmond & Mura, 2023), or the business sector. Businesses are pivotal in creating and implementing innovations. Innovation activities, research, development, knowledge transfer, and the knowledge economy in the context of digitalisation are significant prerequisites for survival and enhancing the competitiveness of companies in a fierce market environment (Androniceanu, 2023). In the EU countries, tools are established to motivate the private sector to conduct research activities within their business operations. Companies are encouraged to invest a larger volume of their resources in R&D and create jobs for scientific workers. Leading countries in the EU in terms of financing R&D in the business sector include Sweden, Austria, France, and Germany. In principle, there is a different approach to implementing innovative procedures in the private and public sectors (Jans et al., 2015), with the process in the public sector perceived as less dynamic (Christensen et al., 2016; Androniceanu et al., 2023). The loss of dynamics in the public sector is mainly caused by regulations connected with a need for efficient, effective and economical/cost-effective usage of public funds and public sources in general (Kučera & Nemec, 2022). This situation may be because incentives leading to innovation in the public sector are more the result of political and legislative efforts than market forces. Moreover, their implementation is often accompanied by a lack of financial and human resources (Rusaw, 2007). Cifranič and Valach (2017) suggest that employers and education providers should step into one another's world to understand each other's situation better. It is therefore evident that to overcome these fundamental differences, it is necessary that the companies, as representatives of the business sector, cooperate closely with universities and vice versa. Universities should seek to establish cooperation with companies in the common sector as much as possible.

A country's economic productivity level is influenced by a set of institutions, policies, internal and external factors (Sun et al., 2023). States are intermediaries that influence how firms can be competitive. Because it is increasingly difficult for firms to compete based on price factors (factors of production), they must strive to produce with a high share of knowledge. Knowledge, especially in terms of innovation, is vital to maintaining a productive economy and enables companies from developed countries to face competition from developing economies to succeed in globalised markets (Cooke, Boekholt & Tödtling, 2000). SMEs possess the capability to introduce and implement innovations. Present economic growth theories emphasise the innovative capacities of these enterprises.

In comparison to larger corporations, SMEs operate more efficiently and enhance the competitiveness of regions and countries. A prevalent trend within the SME sector is innovative entrepreneurship. This form of entrepreneurship responds to current market challenges characterised by intense competitive pressure, prompting businesses to explore new products and service innovations. These innovations are designed to meet the unmet needs of market participants and differentiate the company's activities from those of other entities. Innovative entrepreneurship derives its strength from innovations that can provide a competitive edge. The genesis of these innovations lies in knowledge (Mura et al., 2021).

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 11 Number 4 (June)
http://doi.org/10.9770/jesi.2024.11.4(18)

Haneda and Ito (2014) find that internationally engaged firms use more innovation inputs and generate more innovation outputs, and firms with R&D establishments abroad show the best innovation performance.

Innovations represent a competitive advantage for organisations, pushing competitors to move forward, whether in the development of new products or in improving the quality of services provided. Stern and Jaberg (2010) argue that more competitive advantages generally can be achieved with innovations than with old products/services/processes. All innovations carry certain risks. Innovations are a critical survival factor for small and medium-sized enterprises, but they are strongly motivated primarily by the possibility of profit (Warentin, 2002; Tvaronaviciene & Burinskas, 2021; Odei, 2023). However, in the economy of innovation, there is a broad understanding that the innovation process involves significant risks and, therefore, requires organisations to tolerate both risk-taking and failure. The ability of managers and senior employees dealing with risk to implement appropriate combinations of risk management strategies is the driving force behind innovation. Innovators who fail to innovate successfully could learn from the strategies used by successful innovators to manage risk and emulate them, moving away from merely imitating what works elsewhere. Data Envelopment Analysis - DEA and its efficiency models (e.g., Slack Based Model - SBM, Charnes, Cooper and Rhodes Model – CCR) are great tools to manage the risk of investment inputs in a wide range of economic areas (Kučera et al., 2023). The dissemination of innovations is essential for improving the quality and efficiency of the products, services, and processes provided (Torugsa & Arundel, 2017).

The main result of the literature review on the measurement of innovativeness in countries and regions emphasises the complexity and multidimensionality of assessing innovation. It underscores the diversity of approaches and methodologies used to gauge innovativeness across different levels. Gössling and Rutten (2007) found that wealth, cultural diversity, talent, and population density positively influence a region's innovativeness, although the correlation between GDP and innovation was unexpectedly negative. Carrincazeaux and Gaschet (2015) explored the diversity of regional innovation systems in Europe, finding a high level of variability in regional configurations and emphasising the importance of national institutional settings in shaping regional innovation outcomes. Roszko-Wójtowicz and Białek (2019) proposed a methodology for measuring innovativeness growth over time, stressing the need for dynamic assessments to capture changes in innovation performance among EU member states.

There are a number of methods and indicators that are used to measure the innovation performance of countries and regions. One of the most frequently used methods is the Innovation Index, which combines various indicators and measures the ability of countries or regions to innovate. This index may include factors such as research and development spending, number of patents, level of education and support for innovation in the business environment. Other possible methods include the Innovation Performance Index, the Global Innovation Index or methods based on specific indicators, such as the number of patents, shares of R&D expenditure in GDP, share of innovative firms, etc. (Majerová, 2015).

The European Commission regularly evaluates the innovation activity of individual global economies through the global innovation index, which assesses the overall innovation performance of the monitored global economies and compares it with the EU. The European Innovation Scoreboard 2023, published by the European Commission, shows that innovation performance continues to improve across the EU. It increased the most in Cyprus, Estonia, Greece, Italy and Lithuania. Convergence continues within the EU, with poorer performers growing faster than higher performers, narrowing the innovation gap between them. The European Innovation Scoreboard 2023 is based on 32 indicators grouped into 12 dimensions: human resources, attractive research systems, fixed investments in research and development, finance and support, innovation-friendly environment, intellectual assets, use of information technology, impact on employment and trade and more. Based on the number of points, EU countries are divided into four performance groups: innovation leaders (their innovation performance is above the EU average), strong innovators (their innovation performance is below the leaders but above the EU average), moderate innovators (their innovation performance is below the EU average) and emerging innovators (their innovation performance is below the EU average, but the growth rate in terms of innovation is above the EU average) (European Commission, 2023).

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 11 Number 4 (June)
http://doi.org/10.9770/jesi.2024.11.4(18)

A notable research gap exists in the detailed analysis of barriers to innovation within the V4 countries, particularly in terms of regulatory challenges and the effectiveness of technology transfer. Addressing these gaps is essential for developing effective strategies that overcome innovation obstacles and enhance regional economic competitiveness.

3. Research objective and methodology

The content of this scientific publication relates to the effects of innovations in selected V4 countries. The first objective of the article is to explore the relationships between expenditures on research, development, and innovation on the one hand and various types of innovative activity and market expansion on the other. We also examined the extent of the impact of public financial support on the level of innovativeness.

The data used to prepare this study were obtained from a survey on the innovation activities of the V4 countries. The data result from processing information over the years 2014 to 2022. We focused on the level of innovation activities, considering innovation as the introduction of new products/product innovation, the introduction of new methods of production/process innovation, implementation of a new organisation of the company/organisational innovation, and the implementation of new or significantly improved designs or sales methods/marketing innovation. Technological and non-technological innovation aims to improve the use of the company's knowledge in research and development, increase the quality of goods and services or the efficiency of work processes, increase the attractiveness of goods and services, or facilitate the possibility of entering new markets. Enterprises with innovation activity have had any form of innovative activity, i.e., introduced or implemented new products or processes or had ongoing or discontinued innovative activities.

We used the TOPSIS method to compare various parameters. This mathematical method is used to select the best option from a set of alternatives. TOPSIS compares each alternative in terms of its distance from the ideal solution and from the worst possible solution. The goal is to identify the option that is closest to the ideal and farthest from the negative extreme. This method is often used in decision-making processes (Odu, 2019, Wang et al., 2019).

The TOPSIS method can be described by the following steps (Triantaphyllou, 2000, Ardielli, 2019):

- Creating the criteria matrix $Y=(y_{ij})$ based on input data

$$Y=\begin{pmatrix} y_{11} & y_{12} & \cdots & y_{1n} \\ y_{21} & y_{22} & \cdots & y_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ y_{m1} & y_{m2} & \cdots & y_{mn} \end{pmatrix}$$

- Creating the normalised matrix $R=(r_{ij})$ in the given form

$$r_{ij} = \frac{y_{ij}}{\sqrt{\sum_{i=1}^{m} y_{ij}^2}}\ ; i = 1, 2, \dots, m;\ j = 1, 2, \dots, n.$$

- Creating the weighted normalised matrix $Z=(z_{ij})$

$$z_{ij} = w_j r_{ij};\ \ i = 1, 2, \dots, m;\ j = 1, 2, \dots, n.$$

- Determining solutions in the given form

$$h_j = \max_i z_{ij}\ ; j = 1, 2, \dots, n$$
$$d_j = \min_i z_{ij}\ ; j = 1, 2, \dots, n$$

- Calculating the distance between each alternative

$$d_i^+ = \sqrt{\sum_{j=1}^{n} \left(z_{ij} - h_j\right)^2}\,;\ i = 1, 2, \ldots, m$$

$$d_i^- = \sqrt{\sum_{j=1}^{n} \left(z_{ij} - d_j\right)^2}\,;\ i = 1, 2, \ldots, m$$

- Calculating the relative distance indicator for each alternative in this form

$$c_i = \frac{d_i^-}{d_i^+ + d_i^-}\,;\ i = 1, 2, \ldots, m.$$

To determine the ranking of countries in terms of innovation level, indicators were selected and divided into two groups: input and output (Table 1).

Table 1. Selected input-output indicators

	Code	Indicator	Description
Input indicators	K1	Government expenditure in R&D to the business enterprise sector	Including government expenditures in the innovation index allows monitoring and evaluating the level of government engagement in supporting innovative activity and tracking developments in this direction over time. This provides a comprehensive view of a country's innovation environment and enables comparison with other countries and regions
	K2	Government expenditure in R&D to the government sector	This indicator can be useful in assessing the government's commitment to supporting scientific research and technological development.
	K3	Number of employees in corporate, private R&D	The indicator of the number of people employed in research and development in the private sector is an important prerequisite for staffing research and development.
	K4	Number of all R&D employees across all sectors	This indicator measures the number of R&D employees in the governmental, private, higher educational and non-profit sectors.
Output indicators	K5	Manufacturing Value Added (MVA) per capita	This indicator measures the manufacturing sector's contribution to economic production per capita and is important for assessing a country's economic performance in terms of innovative technologies.
	K6	Eco-Innovation	This indicator deals with innovations leading to improved resource utilisation, reduction of greenhouse gas emissions, protection of natural resources and ecosystems, and the support of renewable energy sources.
	K7	Product innovators (SMEs)	Small and medium enterprises focusing on product innovations usually invest in research and development and collaborate with external partners such as universities, research institutes, or other businesses to access new technologies and know-how. These companies can be key players in stimulating growth and innovation within the economy and can significantly impact job creation and economic development.

Source: own processing

4. Results and discussion

One of the fundamental indicators for assessing a country's research and development level is the ratio of gross domestic expenditures on research and development to the GDP of the respective country (GERD). The

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 11 Number 4 (June)
http://doi.org/10.9770/jesi.2024.11.4(18)

development of gross domestic expenditures on research and development activities as a percentage of GDP for selected V4 countries is shown in Figure 1.

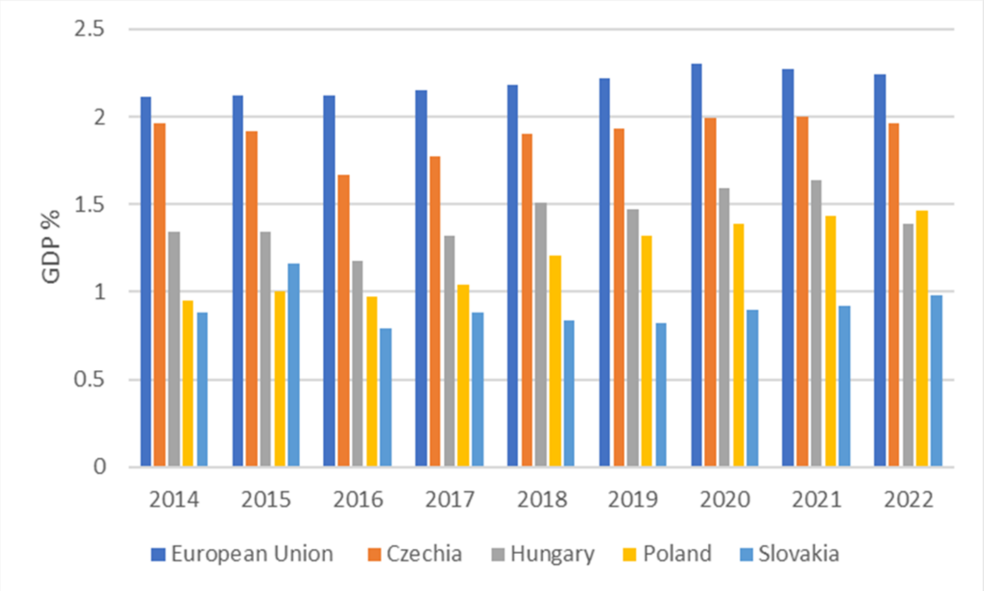

Figure 1. Development of the GERD to GDP ratio in % in the V4 countries in the years 2014-2022

Source: own processing

The value of the observed indicator in all four analysed countries has long been below the average of the European Union, which was at the level of 2.04 % of GDP in 2015 and at the level of 2.24 % of GDP in 2022. Basic descriptive statistics for the observed indicator over a period of 14 years across all four compared countries are presented in Table 2.

Table 2. Descriptive Statistics for the GERD Ratio

	CZ	**HU**	**PL**	**SK**
Min	1.67	1.18	0.95	0.79
Max	2.00	1.64	1.46	1.16
Average	1.90	1.42	1.20	0.91
Median	1.93	1.39	1.21	0.88
Standard deviation	0.11	0.15	0.21	0.11

Source: own processing

Based on these statistical indicators, we constructed a BoxPLot for the proportion of GERD. The value of the indicator expressing the share of gross domestic expenditures on research and development as a percentage of GDP has changed. All countries showed a lower value in that indicator than the EU average. The Czech Republic showed the highest share of spending on research and development from GDP, followed by Hungary, Poland and Slovakia (Fig. 2).

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 11 Number 4 (June)
http://doi.org/10.9770/jesi.2024.11.4(18)

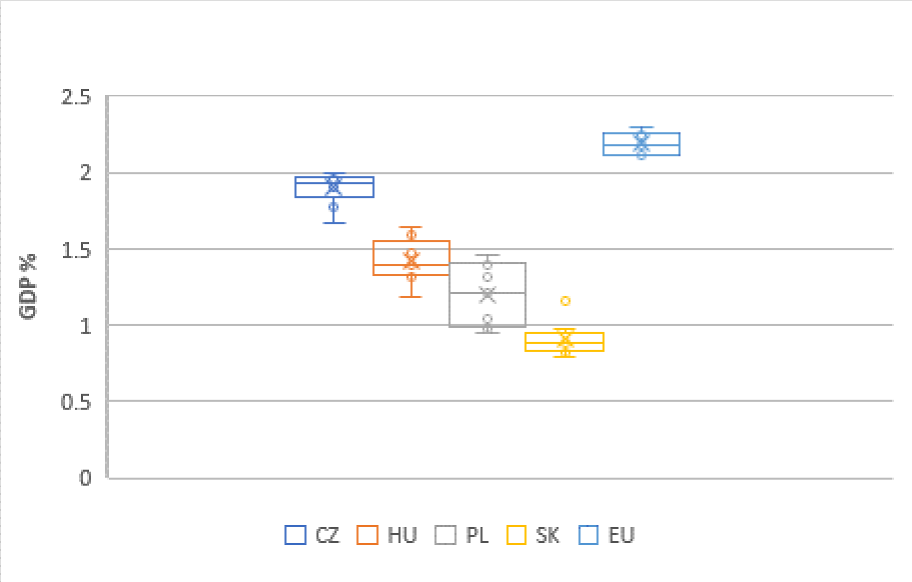

Figure 2. BoxPlot for the proportion of GERD

Source: own processing

At the beginning of the observed period, Hungary spent almost twice as much financial resources as Slovakia. Their volume, as in the other two V4 countries, gradually increased over the years to almost 1.5 billion € in 2015 and 2.3 billion € in 2022. In Poland, the volume of expenditures increased over the observed years from 3.8 billion € to 9.5 billion € (Fig. 3).

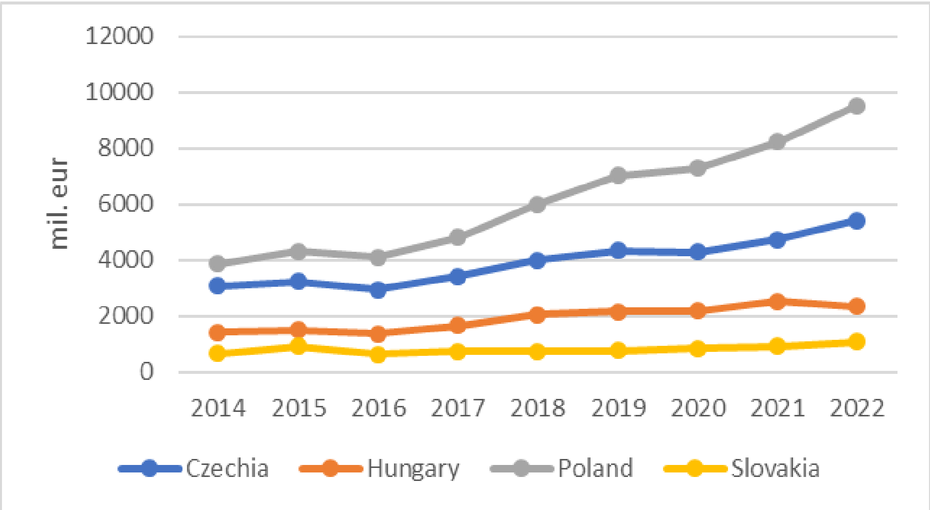

Figure 3. Development of GERD in million € in V4 countries in 2014-2022

Source: own processing

In our opinion, the indicator expressing the size of expenditures on research and development activities per capita has a greater explanatory value. The arrangement of the four countries analysed and compared is slightly different if we compare them using the total volume of expenditures. Expenditures per capita in Slovakia and Poland developed roughly equally for many years. Changes have occurred only in recent years. In Slovakia, they increased from 123.6 € in 2014 to 197.8 € in 2022, in Poland from 101.6 € to 253.3 € per capita. As for the European Union, the observed value was 561.2 € in 2014 and reached 793.3 € in 2022 (Fig. 4).

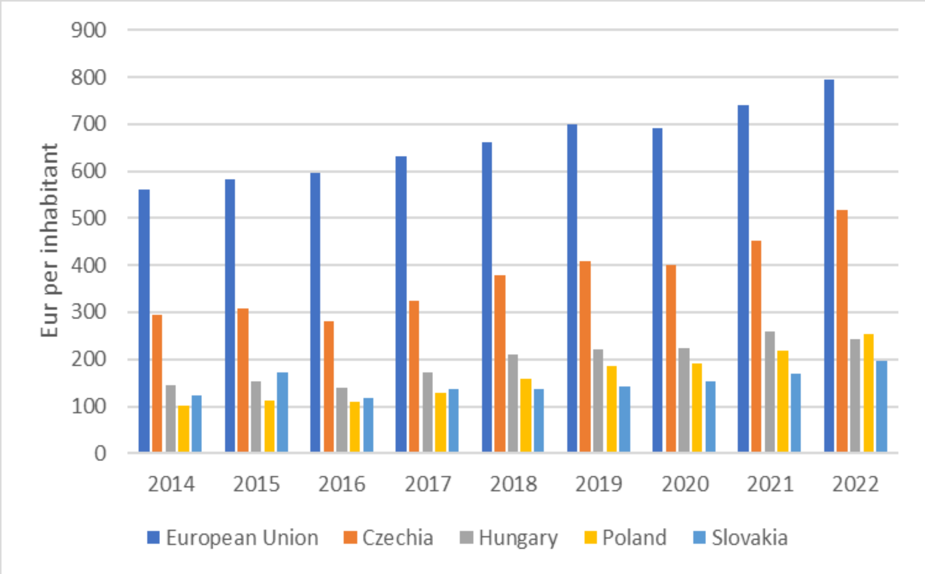

Figure 4. The volume of research and development expenditures per capita in € in the V4 countries in the years 2014-2022

Source: own processing

The structure of research and development expenditures can also be analysed from a different perspective, such as in terms of the activities on which these expenditures are spent. The European Commission, in monitoring expenditures on research and development activities, distinguishes the following categories:

- Expenditures related to the acquisition of machinery, equipment, and software (1)
- Expenditures on acquiring external knowledge (2)
- Expenditures on other innovation activities, such as training and marketing (3)
- Expenditures on external research and development (4)
- Expenditures on internal research and development (5)

Based on the analysis of indices and parameters that influence a country's performance, we established parameters for comparing performance in the given area of the V4 countries. The research methods' chapter describes the individual parameters and reasons for their selection. In this part of the contribution, we analyse innovation activities in the V4 countries according to 7 criteria, with the reference period being 2014 and 2022. We normalised the data to be on the same scale. In this way, we compiled a criterion matrix for the individual years we wanted to compare (Tables 3, 4).

Table 3. Criteria matrix 2014

	K1	K2	K3	K4	K5	K6	K7
CZ	2910944.4	343789.9	1243013741.0	4152964692.3	25495430.5	8576.6	6162.3
HU	1044467.6	38544.7	491819329.0	1393454241.0	7128366.0	2771.0	4225.0
PL	3240309.6	36011.9	17079209.3	309548836.0	14944409.6	4641.7	3708.8
SK	60850.0	856607.6	1387793459.6	10890842624.6	6156849.7	2157.6	2916.0
Total	**7256571.7**	**1274954.1**	**3139705738.9**	**16746810393.9**	**53725055.8**	**18146.9**	**17012.1**

Source: own processing

Table 4. Criteria matrix 2022

	K1	K2	K3	K4	K5	K6	K7
CZ	12140827.3	754874.3	2566678773.8	7417446725.2	25441936.0	12316.6	18577.7
HU	2855522.0	82766.7	1453134400.0	3929785344.0	8702500.0	6585.3	4733.4
PL	39509169.6	34052.4	85205822.5	544932998.4	12531600.0	8913.2	1840.4
SK	378282.8	33972.4	13400701730.0	38062293139.4	6848689.0	4538.7	1892.3
Total	**54883801.8**	**905665.8**	**17505720726.2**	**49954458207.0**	**53524725.0**	**32353.8**	**27043.8**

Source: own processing

Upon obtaining the necessary input data, the initial phase involved assigning significance to the specified criteria through weighting. To achieve the highest level of objectivity in our evaluation, we adopted two distinct methodologies to distribute weights across the criteria. In the first method, we applied an equal-weight approach. This uniform distribution ensures that no single criterion disproportionately influences the overall evaluation. Conversely, Method II, known as the entropy method, calculates weights based on the variability within the input data, as detailed in Table 5. This method leverages the inherent information provided by the data to assign weights, ensuring that criteria with greater variability have a correspondingly higher impact on the evaluation. Both methods, the equal weights and the entropy method, are rigorously dependent on the characteristics and quality of the input data, underscoring the critical role that precise and accurate data plays in our analytical process.

Table 5. Criteria weights

Criteria **Weights**	K1	K2	K3	K4	K5	K6	K7
Method I in 2014 and 2022	0.1428	0.1428	0.1428	0.1428	0.1428	0.1428	0.1428
Method II in 2014	0.1401	0.1379	0.1393	0.1398	0.1468	0.1472	0.1486
Method II in 2022	0.1378	0.1389	0.1373	0.1393	0.1503	0.1512	0.1453

Source: own processing

After assigning weights to the individual criteria, we used two methods to rank the alternatives. The first method used for evaluating the countries was the TOPSIS method with equal value of assigned weights, as shown in Table 6. Equal weights can reflect the principle of fairness and equality among different criteria.

Table 6. TOPSIS method 2014

	di+	di-	ci
CZ	0.062	1.213	0.951
HU	1.052	0.175	0.142
PL	0.658	0.572	0.465
SK	1.208	0.158	0.116

Source: own processing

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 11 Number 4 (June)
http://doi.org/10.9770/jesi.2024.11.4(18)

We carried out the same process with the analysis of data from the relevant area measured in 2022. The relevant results are presented in Table 7.

Table 7. TOPSIS method 2022

	di+	di-	ci
CZ	0.113	0.165	0.594
HU	0.188	0.054	0.224
PL	0.208	0.113	0.351
SK	0.180	0.159	0.469

Source: own processing

Within the TOPSIS method, a relative closeness indicator c_i is used to evaluate alternatives based on the distance of each alternative from the baseline variant. This indicator is calculated based on the distance of each alternative from the ideal and undesirable solutions in the given multicriteria decision-making problem. The ranking of the individual examined countries varied from 2014 to 2022 due to the different political and economic directions of the examined countries.

Using entropy, we wanted to verify the results we achieved. TOPSIS using entropy can provide a more objective assignment of weights to criteria based on data distribution. It can be used to consider different data distributions and reflect their relative importance in evaluating alternatives. When evaluating data with entropy, we present the relevant Z matrix. This matrix contains the weighted values of each alternative with respect to the individual criteria. (Table 8, 9).

Table 8. Matrix Z 2014

	K1	K2	K3	K4	K5	K6	K7
CZ	0.088755	0.076997	0.07235	0.063909	0.092427	1731.942	0.083888
HU	0.053165	0.047508	0.024226	0.085876	0.058139	1003.23	0.07453
PL	0.093642	0.103289	0.023416	0.06937	0.010834	472.8449	0.067846
SK	0.012832	0.013306	0.114205	0.057292	0.097662	2804.69	0.070018

Source: own processing

Table 9. Matrix Z 2022

	K1	K2	K3	K4	K5	K6	K7
CZ	0.064799	0.049565397	0.12534	0.054328	0.057544	0.058253	0.080281
HU	0.031426	0.037823391	0.041503	0.07621	0.043298	0.042401	0.074654
PL	0.116894	0.123519702	0.026621	0.076813	0.010484	0.015789	0.070339
SK	0.011438	0.012330361	0.02659	0.068871	0.131485	0.131959	0.064337

Source: own processing

In summary, in Table 10, the resulting values of the relative closeness indicator in the reference years 2014 and 2022 are displayed to compare the development or changes over time. These values provide an overview of performance, trends, or change in the evaluation of the given indicators between these two years. Analysing

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 11 Number 4 (June)
http://doi.org/10.9770/jesi.2024.11.4(18)

these values makes it possible to identify whether the condition or situation in the given period has improved, worsened, or remained stable.

Table 10. TOPSIS method

	Method I 2014	Rank	Method I 2022	Rank	Method II 2014	Rank	Method II 2022	Rank
TOPSIS	c_i		c_i		c_i		c_i	
CZ	0.951	1	0.594	1	0.999	1	0.532	1
HU	0.142	3	0.224	4	0.539	2	0.257	4
PL	0.465	2	0.351	3	0.221	4	0.443	3
SK	0.116	4	0.469	2	0.354	3	0.536	2

Source: own processing

Based on the obtained results, we determined the final ranking of the countries in terms of innovations and chosen criteria using both methods, TOPSIS with equal weights and entropy. For a better presentation of the summary results, we present them in Figure 5.

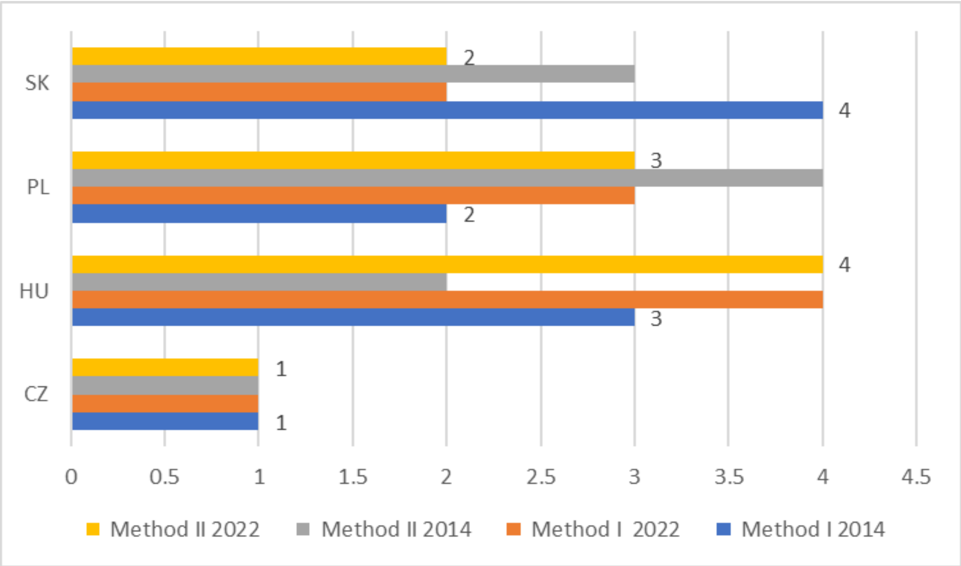

Figure 5. Average rank of the countries

Source: own processing

An interesting finding is that the Czech Republic emerged as a leader within the V4, as evidenced by the results from 2014, but a significant shift occurred in the ranking of Slovakia. This was likely influenced by the sixth criterion, which deals with eco-innovations that lead to the improvement of resource utilisation, reduction of greenhouse gas emissions, protection of natural resources and ecosystems, as well as the support of renewable energy sources, where Slovakia becomes a leader within the V4. All the countries of the Visegrad Group are classified among moderate innovators, with their innovation index values being below the EU-27 average. The Czech Republic is best positioned among all the Visegrad Group countries. Hungary is at the opposite end of this spectrum with the lowest innovation performance based on our reasoned parameters.

Based on our results and other indicators freely available in EU statistics, we can make the following statements about individual countries:

Slovakia ranks among moderate innovators. During the observed period, Slovakia's performance was up to 32 % lower than the EU-27 average. Slovakia's performance improved significantly until 2013, but there was a decline from 2013 to 2018. Within Slovakia's innovation system, relatively strong areas were identified in categories such as impact on employment, impact on sales, and human resources. On the contrary, relative weaknesses were shown in categories like innovators, intellectual assets, and attractive research systems. Currently, Slovakia is still considered a moderate innovator. Slovakia still has a lower level of innovation performance than other European Union countries. However, Slovakia is improving its innovation potential and strengthening its innovation system through various initiatives and policies. These initiatives include various financial incentives, grant programs, support for research and development in the public and private sectors, and support for startups and emerging companies.

The Czech Republic also belongs to moderate innovators. The Czech Republic's performance was 14 % lower than the EU-27 average during the reported period. In the case of the Czech Republic, annual performance changed relatively moderately. Over time, performance decreased by 4 % compared to the EU performance. During this time, the Czech Republic is trying to strengthen its innovation infrastructure, such as technology parks, innovation centres, and incubation programs, providing space and support for innovative companies. Among the V4 countries, the Czech Republic is the most actively involved in various international programs, such as Horizon 2020, which provides access to financing and the opportunity to collaborate on research projects and better innovation performance.

Poland is among the moderate innovators. During the reported period, Poland's performance was 47 % lower than that of EU-27 countries. The relatively strong sides of Poland's innovation system are identified in these categories: impact on employment, corporate investments, and an environment favourable for innovations. Relative deficiencies were found in categories: innovators and connections to the academic ground. In recent years, Poland has been increasing investments in research and development. According to Eurostat data, in 2020, Poland's total research and development expenditures amounted to approximately 1.17 % of its Gross Domestic Product. Patent activity is an indicator of innovation. In recent years, Poland has seen an increase in the number of patent applications filed at national and international levels, reflecting the country's growing innovation efforts. Poland has a rapidly developing startup ecosystem, with a multitude of startups emerging in various sectors including technology, biotechnology, fintech, and e-commerce.

Hungary is also a moderate innovator. During the reported period, Hungary's performance was 32 % lower than the EU-27 countries. In the case of Hungary, there was a decline in performance until 2014, after which there was an increase in performance from 2014 to 2017. The relatively strong sides of Hungary's innovation system are identified in these categories: impact on employment, sales impact, and an environment favourable for innovations. Hungary is increasing its investments in research and development. According to Eurostat data, in recent years, Hungary's total research and development expenditures as a percentage of GDP have been approximately 1.4 % to 1.5 %, reflecting the country's commitment to supporting innovation.

The European Innovation Scoreboard 2023, published by the European Commission, declares that Denmark is the new top innovator with the best performance in the EU, having overtaken Sweden as the leader after several years. Other innovation leaders are Sweden, Finland, the Netherlands and Belgium. Austria, Germany, Luxembourg, Ireland, Cyprus and France are strong innovators, performing above the EU average. Estonia, Slovenia, Czech Republic, Italy, Spain, Malta, Portugal, Lithuania, Greece and Hungary are moderate innovators. Croatia, Slovakia, Poland, Latvia, Bulgaria and Romania are new innovators (European Commission, 2023).

In discussing our findings on the innovation performance and strategies of the V4 countries, it's crucial to consider the broader academic context, which sheds light on the multifaceted nature of innovation dynamics within these nations.

Pavlík et al. (2022) identify potential areas for the V4 to enhance their position within the European innovation ecosystem. They emphasise the need for improvements in specific European Innovation Scoreboard indicators, suggesting that targeted efforts could significantly bolster the V4's innovation capabilities and standings. This perspective aligns with our observations of the varying performance levels and the identified areas for improvement across the V4 countries.

Similarly, Pařízková and Šipikal (2009) delve into the evaluation of innovation support through the creation of regional innovation strategies in these countries. By comparing their approaches to both theoretical backgrounds and each other, they provide a nuanced understanding of how each country's unique strategy and implementation impact its innovation outcomes. This comparative analysis complements our findings by highlighting the importance of tailored, region-specific innovation policies and strategies.

Spišáková (2011) specifically highlights the Czech Republic's classification as a "moderate innovator," noting its position as the closest to the European average among the V4. This variability underscores the potential for leveraging unique national strengths. Our analysis concurs with this view, pointing to the Czech Republic's relatively stronger innovation performance and the potential for other V4 countries to identify and leverage their unique strengths.

Kowalska et al. (2018) highlight the direct correlation between R&D expenditure and innovation performance, alongside the significance of broader economic metrics like GDP and foreign trade in understanding the innovation landscape. These perspectives support our findings on the crucial role of investment in R&D and the broader economic context in driving innovation.

Together, these scholarly works provide a comprehensive backdrop to our analysis, underlining the importance of a holistic approach to enhancing innovation performance in the V4 countries. By considering both the specific areas for improvement identified in our study and the insights offered by these researchers, policymakers and stakeholders can better navigate the challenges and opportunities in fostering innovation within the V4 context.

Conclusions

This study has rigorously examined the innovation performance of the Visegrad Four (V4) countries, underscoring the pivotal role of innovation in driving economic development and competitiveness on the global stage. Our findings categorically position the Czech Republic as the most innovative among the V4, attributed to its substantial investment in research and development (R&D) relative to GDP and a robust industrial sector that actively supports innovation initiatives. This places the Czech Republic at the forefront of innovation performance within the V4 across the years 2014 and 2022, aligning with the European Commission's classification of moderate innovators. The remaining V4 countries—Slovakia, Poland, and Hungary—also qualify as moderate innovators. However, the innovation landscape has seen shifts over the years. Notably, Slovakia's emphasis on eco-innovations has elevated its ranking, showcasing the impact of strategic focus areas on overall innovation performance.

Our analysis reveals several barriers to innovation across the V4, including limited financial resources for innovative activities, particularly in the private sector, high innovation costs, and challenges in securing state or grant funding. Additionally, the lack of collaboration partners and qualified personnel for innovation implementation emerged as significant obstacles, especially for small and medium-sized enterprises (SMEs).
To surmount these challenges and enhance innovation performance, the study recommends enhanced financial and policy support for R&D and innovation activities, particularly targeting SMEs; strategic focus on sectors with high innovation potential, such as eco-innovations, to leverage unique strengths and opportunities within each country; facilitation of collaboration between academia, industry, and government to foster a vibrant innovation ecosystem that supports knowledge transfer and commercialisation of research.

Conclusion, while the V4 countries demonstrate a commendable commitment to fostering innovation, there is a need for targeted strategies to overcome existing barriers and fully leverage their innovation potential.

The study's novelty lies in its comprehensive application of the TOPSIS method to assess the innovation performance of the V4 countries, providing insights into regional development and economic competitiveness. However, it has limitations, including its reliance on potentially outdated data and a focus on macro-level indicators that may overlook detailed micro-level dynamics in innovation. These constraints suggest areas for further research. Strengthening the innovation ecosystem through comprehensive support mechanisms and fostering collaboration can significantly enhance their economic development and competitiveness on the international stage.

References

Ardielli, E. (2019). Use of TOPSIS Method for Assessing of Good Governance in European Union Countries. *Review of Economic Perspectives*, 19(3), 211-231. https://doi.org/10.2478/revecp-2019-0012

Androniceanu, A., Georgescu, I., & Sabie, O.-M. (2022). The impact of digitalisation on public administration, economic development, and well-being in the EU countries. *Central European Public Administration Review*, 20(1), 7-29. https://doi.org/10.17573/cepar.2023.1.01

Androniceanu, A. (2023). The new trends of digital transformation and artificial intelligence in public administration. *Administratie si Management Public*, 40, 147-155. https://doi.org/10.24818/amp/2023.40-09

Androniceanu, A., Sabie, O.M., Georgescu, I., & Drugău-Constantin, A.L. (2023). Main factors and causes that are influencing the digital competences of human resources. *Administratie si Management Public*, 41, 26-53. https://doi.org/10.24818/amp/2023.41-02

Carrincazeaux, C., & Gaschet, F. (2015). Regional innovation systems and economic performance: Between regions and nations. *European Planning Studies*, 23(2), 262-291. https://doi.org/10.1080/09654313.2013.861809

Cifranič, M., & Valach, M. (2017). Innovative approaches to system of education focusing on business. XX. mezinárodní kolokvium o regionálních vědách. Brno: Masarykova univerzita, Ekonomicko-správní fakulta.

Civelek, M., & Krajčík, V. (2022). How do SMEs from different countries perceive export impediments depending on their firm-level characteristics? System approach. *Oeconomia Copernicana*, 13(1), 55-78. https://doi.org/10.24136/oc.2022.002

Clark, G., Huxley, J., & Mountford, D. (2010). *Organising Local Economic Development: The Role of Development Agencies and Companies*. OECD. https://doi.org/10.1787/9789264083530-en

Crescenzi, R., & Rodriguez-Pose, A. (2011). *Innovation and regional growth in the European Union*. Berlin: Springer. https://doi.org/10.1007/978-3-642-17761-3

Cooke, P., Boekholt, P., & Tödtling, F. (2000). *The governance of innovation in Europe: Regional perspectives on global competitiveness*. Pinter.

Dušek, R., & Sagapova, N. (2022). Instagram Use among Czech Young Generation during COVID-19 Lockdown Period with Restricted Travel and Services. *Journal of Tourism and Services*, 24(13), 150-163. https://doi.org/10.29036/jots.v13i24.350

Espino-Rodríguez, T.F., Gebril Taha Admed, M., & Gil-Padilla, A.M.(2022). Outsourcing from the Perspectives of Competitive Capabilities and Supplier Innovation in the Hotel Sector. *Journal of Tourism and Services*, 25(13), 22-44. https://doi.org/10.29036/jots.v13i25.429

Európska komisia. (2023). *Európsky prehľad výsledkov inovácie: Inovačná výkonnosť sa v členských štátoch a regiónoch EÚ neustále zlepšuje* [European innovation results overview: Innovation performance continues to improve in EU member states and regions]. Retrieved July 27, 2023, from https://research-and-innovation.ec.europa.eu/statistics/performance-indicators/european-innovation-scoreboard_sk

Floriš, N., Schwarcz, P., Schwarczová, L., & Munk, M. (2022). Short food supply chains and small farms - Evidence from Slovakia. *Sustainability*, 14(5), 2728. https://doi.org/10.3390/su14052728

Folgado-Fernández, J. A., Rojas-Sánchez, M., Palos-Sánchez, P. R., & Casablanca-Peña, A. G. (2023). Can Virtual Reality Become an Instrument in Favor of Territory Economy and Sustainability?. *Journal of Tourism and Services*, 14(26), 92-117. https://doi.org/10.29036/jots.v14i26.470

Giguère, S. (2007). *Local innovations for growth in Central and Eastern Europe*. Paris: OECD. ISBN 9264038515. https://doi.org/10.1787/9789264038523-en

Gössling, T., & Rutten, R. (2007). Innovation in regions. *European Planning Studies*, 15(2), 253-270. https://doi.org/10.1080/09654310601078788

Hanáčková, D., Balážová, E., Bumbalová, M., Cifranič, M., Gubáňová, M., & Valach, M., & Rumanovská, Ľ. (2019). *Inovačné aktivity miestnych samospráv*. 1. vyd. Nitra: Slovenská poľnohospodárska univerzita, 171 s. ISBN 978-80-552-2100-7.

Haneda, S., & Ito, K. (2014). Modes of international activities and the innovativeness of firms: An empirical analysis based on the Japanese National Innovation Survey for 2009. *Economics of Innovation and New Technology*, 23(8), 758-779. https://doi.org/10.1080/10438599.2014.904540

Cheah, S. (2016). Framework for measuring research and innovation impact. *Innovation: Management, Policy and Practice*, 18(2), 212–232. https://doi.org/10.1080/14479338.2016.1219230

Cheng, Y.H., Chang, K.C., Cheng, Y.S., & Hsiao, C.J. (2022). How Green Marketing Influences Customers' Green Behavioral Intentions in the Context of Hot-Spring Hotels. *Journal of Tourism and Services*, 24(13), 190-208. https://doi.org/10.29036/jots.v13i24.352

Christensen, H. S., Karjaleinen, M., & Lundell, K. (2016). Democratic Innovations to the Rescue? Political Trust and Attitudes towards Democratic Innovations in Southwest Finland. *International Journal of Public Administration*, 39(5), 404-416. https://doi.org/10.1080/01900692.2015.1015560

Jakimowicz, A., & Rzeczkowski, D. (2019). Do barriers to innovation impact changes in innovation activities of firms during business cycle? The effect of the Polish green island. *Equilibrium. Quarterly Journal of Economics and Economic Policy*, 14(4), 631-676. https://doi.org/10.24136/eq.2019.030

Jans, W., Denters, B., Need, A., & Van Gerven, M. (2015). Mandatory innovation in a decentralised system: The adoption of an e-government innovation in Dutch municipalities. *Acta Politica*, 51(1), 36-60. https://doi.org/10.1057/ap.2014.36

Khalifa, G.S.A., Abuelhassan, A.E., Khreis, S.H.A., Soliman, M & Hossain, M.S. (2023). Innovation Mechanism in the Hospitality Industry: A Mediated-Moderated Model. *Journal of Tourism and Services*, 26(14), 173-196. https://doi.org/10.29036/jots.v14i26.492

Ključnikov, A., Civelek, M., Krajčík, V., Novák, P., & Červinka, M. (2022a). Financial performance and bankruptcy concerns of SMEs in their export decision. *Oeconomia Copernicana*, 13(3), 867-890. https://doi.org/10.24136/oc.2022.025

Ključnikov, A., Civelek, M., Klimeš, C., & Farana, R. (2022). Export risk perceptions of SMEs in selected Visegrad countries. *Equilibrium. Quarterly Journal of Economics and Economic Policy*, 17(1), 173-190. https://doi.org/10.24136/eq.2022.007

Kondrla, P., Lojan, R., Maturkanič, P., Biryukova, Y. N., & Gonzalez, M.E. (2023). The philosophical context of curriculum innovations with a focus on competence development. *Journal of Education Culture and Society*, 14(2), 78-92. https://doi.org/10.15503/jecs2023.2.78.92

Kowalska, A., Kovarnik, J., Hamplová, E., & Prazák, P. (2018). The Selected Topics for Comparison in Visegrad Four Countries. *Economies*, 6(3), 50. https://doi.org/10.3390/economies6030050

Krajčík, V., Novotný, O., Civelek, M., & Semrádová Zvolánková, S. (2023). Digital Literacy and Digital Transformation Activities of Service and Manufacturing SMEs. *Journal of Tourism and Services*, 14(26), 242-262. https://doi.org/10.29036/jots.v14i26.551

Kučera, J., & Nemec, J. (2022). Allocation of public funds from the state budget to the national sports associations in Slovakia. *SciPap*, 30(1), 1405. https://doi.org/10.46585/sp30011405

Kučera, J., Zimková, E., Nemec, J., & Nemec, M. (2023). A comparative analysis of the efficiency of public funding policies for sports in the European Union. *Cogent Social Sciences*, 9(2), 242-262. https://doi.org/10.1080/23311886.2023.2280335

Lacko, R., Hajduova, Z., Mura, L., & Dzogan, M. (2023). The Attractiveness of Foreign Direct Investments for Business: the Case of the Selected European Union members. *Transformations in Business & Economics*, Vol. 22, No 2 (59), 27-40

Lincényi, M., & Bulanda, I. (2023). Use of Marketing Communication Tools in Tourism in Accommodation Facilities during the COVID-19 Pandemic. *Journal of Tourism and Services*, 14(26), 25-44. https://doi.org/10.29036/jots.v14i26.440

Maguire, K., Nauwelaers, C., & Primi, A. (2011). *Regions and innovation policy: OECD reviews of regional innovation*. Paris: OECD. ISBN 978-92-64-0978-3.

Majerová, I. (2015). Measurement of Innovative Performance of Selected Economies of the European Union and Switzerland. *International Journal of Information and Education Technology*, 5(3). https://doi.org/10.7763/IJIET.2015.V5.506

Masárová, J., & Ivanová, E. (2023). The relationship assessment between human resources and innovation performance in EU countries. *Economics and Sociology,* 16(4), 191-206. https://doi.org/10.14254/2071-789X.2023/16-4/9

Mishchuk, H., Bilan Y., Androniceanu, A. & Krol, V. (2023). Social capital: Evaluating its roles in competitiveness and ensuring human development. *Journal of Competitiveness*, 15(2), 1-17. https://doi.org/10.7441/joc.2023.02.01

Maturkanič, P., Čergeťová Tomanová, I., & Přibylová, D. (2022). Cyrillo-Methodian Tradition in Czech Society in the 21st Century. *Constantine's Letters,* 15(1), 161-176. https://doi.org/10.17846/CL.2022.15.1.161-176

Mura, L., Krchova, H., & Chovanova Supekova, S. (2021). *Managing the development of innovative and startupstartup forms of businesses and verification of INMARK concept.* Szczecin: Centre of Sociological Research. https://doi.org/10.14254/978-83-963452-2-6/2021

Odei, M. A. (2023). Examination of factors contributing to SMEs Innovation outcomes in the Visegrad Countries [Doctoral dissertation, Tomas Bata University in Zlín]. Retrieved from https://digilib.k.utb.cz/bitstream/handle/10563/52433/odei_2023_dp.pdf?sequence=1&isAllowed=y

Odu, G. O. (2019). Weighting methods for multi-criteria decision making technique. *Journal of Applied Sciences and Environmental Management*, 23(8). https://doi.org/10.4314/jasem.v23i8.7

Oliinyk, O., Bilan, Y., & Mishchuk, H. (2021). Knowledge Management and Economic Growth: The Assessment of Links and Determinants of Regulation. *Central European Management Journal,* 29(3), 20-39. https://doi.org/10.7206/cemj.2658-0845.52

Pařízková, J., & Šipikal, M. (2009). Regional Innovation Strategies in V4 Countries. Bratislava: Univerzita Komenského v Bratislave. https://doi.org/10.2139/ssrn.1659722

Pavlík, T., Jakab, F., & Fedák, V. (2022). Potential Areas of the V 4 to Improve Its Position in the European Innovation Ecosystem. 2022 20th International Conference on Emerging eLearning Technologies and Applications (ICETA), Stary Smokovec, Slovakia, 2022, pp. 502-507. https://doi.org/10.1109/ICETA57911.2022.9974958

Rigelsky, M., Gavurova, B., & Nastisin, L. (2022). Knowledge and Technological Innovations in the Context of Tourists' Spending in OECD Countries. *Journal of Tourism and Services*, 25(13), 176-188. https://doi.org/10.29036/jots.v13i25.460

Roszko-Wójtowicz, E., & Białek, J. (2019). Measurement of the average innovativeness change over time in the EU member states. *Journal of Business Economics and Manag*ement, 20(2), 268-293. https://doi.org/10.3846/jbem.2019.8337

Rusaw, C. A. (2007). Changing public organisations: Four approaches. *International Journal of Public Administration*, 30, 347-361. https://doi.org/10.1080/01900690601117853

Spišáková, E. (2011). Analysis of Innovation Activity of Slovak and Czech Enterprises. *Quality Innovation Prosperity*, 14(1-2). https://doi.org/10.12776/qip.v14i1-2.33

Staroňová, K., et al. (2012). *Inovácie vo verejnom sektore: Prípadové štúdie* [Innovations in the public sector: Case studies]. Bratislava: Univerzita Komenského v Bratislave. Centrum excelentnosti pre spoločenské inovácie UK. ISBN: 978-80-223-2997-5.

Stern, T., & Jaberg, H. (2010). *Erfolgreiches Innovationsmanagement: Erfolgsfaktoren - Grundmuster - Fallbeispiele* [Successful Innovation Management: Success Factors - Basic Patterns - Case Studies]. Wiesbaden: Gabler. ISBN 9783834922458.

Streimikiene, D. (2023). Sustainability Assessment of Tourism Destinations from the Lens of Green Digital Transformations. *Journal of Tourism and Services,* 14(27), 283-298. https://doi.org/10.29036/jots.v14i27.651

Sun, Q.Y., Li, L., & Liu, L. (2023). Impact of Tax Incentives on Technological Innovation Inputs and Outputs of Manufacturing Firms: The Moderating Effect of Regional Marketization. *Transformations in Business & Economics*, Vol. 22, No 1 (58), pp.149-164.

Tadevosyan, R. (2023). Innovations and international competitiveness: Country-level evidence. *Economics and Sociology, 16*(3), 248-260. https://doi.org/10.14254/2071- 789X.2023/16-3/13

Torugsa, N., & Arundel, A. (2017). Rethinking the effect of risk aversion on the benefits of service innovations in public administration agencies. *Research Policy*, 46(5), 900-910. https://doi.org/10.1016/j.respol.2017.02.002

Triantaphyllou, E. (2000). *Multi-criteria Decision Making Methods: A Comparative Study*. Boston, MA: Springer. https://doi.org/10.1007/978-1-4757-3157-6

Tvaronaviciene, M., & Burinskas, A. (2021). Internal funding determinants of R&D expenditures for U.S. mature firms. *Journal of International Studies,* 14(1), 276- 284. https://doi.org/10.14254/2071-8330.2021/14-1/19

Wang, M., Zhao, X., Gong, Q., & Ji, Z. (2019). Measurement of Regional Green Economy Sustainable Development Ability Based on Entropy Weight-Topsis-Coupling Coordination Degree—A Case Study in Shandong Province, China. *Sustainability,* 11(1), 280. https://doi.org/10.3390/su11010280

Wach, K., & Daszkiewicz, N. (2023). Role of research and development in the internationalisation of high-tech firms: Empirical results from Poland. *Journal of International Studies,* 16(4), 245-256. https://doi.org/10.14254/2071-8330.2023/16-4/16

Warkentin, M., Gefen, D., Pavlou, P. A., & Rose, G. M. (2002). Encouraging citizen adoption of e-government by building trust. *Electronic Markets*, 12(3), 157–162. https://doi.org/10.1080/101967802320245929

Zhang, Y.Q., Sadiq, M., & Chien, F.S. (2023). The Role of Eco-innovation on the Business Sustainability in China: Moderating Role of Organizational Innovation Culture. *Transformations in Business & Economics*, Vol. 22, No 2 (59), pp.144-160.

Zsigmond, T., & Mura, L. (2023). Emotional intelligence and knowledge sharing as key factors in business management – evidence from Slovak SMEs. *Economics and Sociology*, 16(2), 248-264. https://doi.org/10.14254/2071-789X.2023/16-2/15

Funding: This research was funded by the Scientific Grant Agency of the MoESRS and the Slovak Academy of Sciences under contract No. VEGA-1/0437/22

Author Contributions: Conceptualisation: *Hanáčková; Takáč;* methodology: *Hanáčková*; data analysis: *Hanáčková;* writing—original draft preparation: *Takáč*; writing; review and editing: *Takáč;* visualisation: *Hanáčková*. All authors have read and agreed to the published version of the manuscript.

Denisa HANÁČKOVÁ is the Assistant Professor at Slovak Agricultural University, Faculty of European Studies and Regional Development, Academic title: Ing., PhD., Research interests: innovations, public services, public economics
ORCID ID: http://orcid.org/0009-0004-9823-8769

Ivan TAKÁČ is the Associate Professor at Slovak Agricultural University, Faculty of European Studies and Regional Development, Academic title: doc., Ing., PhD., Research interests: project management, innovations, co-working
ORCID ID: **http://**orcid.org/0000-0001-6270-9806