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Competitiveness and Digital Transformation in the Eastern European Countries: A Comparative Analysis of Indicators

Lejla Terzić*

Abstract: The paper's goal is to compare the relationship between competitiveness and digital transformation indicators in the Eastern European countries. The World Competitiveness Index, digital transformation index, government efficiency index, business efficiency index, infrastructure index, World Digital Competitiveness Index, knowledge index, technology index, and future readiness index represent the crucial examined indicators. These indices were chosen in order to thoroughly evaluate the level of digital transformation and how it relates to national competitiveness. The comparative analysis employed different methodologies and actual ratings by using representative data. The relationships between important variables have been examined using Spearman's testing of hypotheses. The competitiveness and digital transformation indicators are shown to be strongly positively correlated. A comparative analysis of the Eastern European countries discovered a strong positive correlation between the analyzed indicators, showing that competitiveness is associated with a higher level of digital transformation. The analysis offers an essential dataset for Eastern European countries' comparisons and indicates suggestions for long-term assessments of the relationship between competitiveness and digital transformation. A higher WCI score, which reflects global competitiveness, is connected with high DTI, GEI, BEI, INF, WDCI, KI, TI, and FRI scores. Policies that improve digital infrastructure, talent development, and innovation frameworks are necessary, as seen by the differences in digital transformation levels among nations. The competitiveness and digital transformation key indicators' rankings and scores can be vital for future cross-national comparisons and provide helpful recommendations for policymakers.

Keywords: competitiveness; digital transformation; comparative analysis; indicators; Eastern European countries.

JEL classification: A10; C80; O30; O57.

* Department of Theoretical Economics, Policy and Development, Faculty of Economics Brčko, University of East Sarajevo, Bosnia and Herzegovina; e-mail: *lejla.terzic.efb@gmail.com*.

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1. INTRODUCTION

The assessment of progressively globalizing countries toward competitiveness and digital transformation has been emphasized as an important topic in modern economic theory and policy. Competitiveness analysis in relation to digital transformation continues to be a top focus worldwide. However, these topics have not been thoroughly examined in the most recent scientific publications due to the diversity of their characteristics and viewpoints. In the past, differentiated products, economies of scale, and cost-effectiveness have all been key components of competitiveness. But as the digital age has progressed, knowledge-based elements such as knowledge capital, employee talent, company image, and innovation capabilities have become important in the competitive environment.

The idea of competitiveness has been significantly redefined by digital transformation (Ashmarina *et al.*, 2020; Enri-Peiró *et al.*, 2025). Businesses must incorporate digital technologies into their fundamental procedures in order to stay competitive. Basically, every aspect of a contemporary, inventive economy and society depends on sophisticated digital infrastructure (Venkatraman, 2017). Digital competitiveness, as a component of the wide-ranging competitiveness approach, is a complex structure that includes different aspects of digital transformation via the capacity to acquire and utilize new technologies that facilitate digital readiness of economies and their citizens.

Considering the range of issues that nations are currently dealing with, a new perspective on analysis would be essential. In order to provide policymakers with more information about the status and direction of competitiveness and digital transformation worldwide, composite analytical indices have become a valuable group of indicators. As an essential tool for decision-makers, the IMD's World Digital Competitiveness Index (WDCI) aims to be a comprehensive, worldwide indicator that monitors the efficiency of digital systems at the national level (IMD, 2025b). The IMD World Competitiveness Index, digital transformation index, government efficiency index, business efficiency index, infrastructure index, and WDCI of the Eastern European countries were examined for certain associations between competitiveness and digital transformation variables.

One of the most important factors influencing a country's economy and potential for sustainability in the future is its competitiveness. However, current publications have not explored the significance of competitiveness for fostering digitalization. This paper provides a comparative analysis of a crucial research issue: Does the Eastern European countries' competitiveness depend on digital transformation? Spearman's investigation of hypotheses has been used for investigation into the associations between significant variables. The study also assessed the significance of Spearman's connections using the rho-p test for hypotheses, which is frequently applied on ordinal parameters. The correlations between the World Competitiveness Index, Digital Transformation Index, Government Efficiency Index, Business Efficiency Index, Infrastructure Index, the World Digital Competitiveness Index, Knowledge Index, Technology Index, and Future Readiness Index were examined using Spearman's rank-order connections.

The study's findings can be useful to governments and significant stakeholders. Future assessments of the competitiveness and the development of appropriate digital transition policies in the Eastern European countries could be possible by variations in the ranking and emphasizing the important indicators. This article is divided into five sections. The introduction is presented in the first section of the article. The theoretical foundations of recent

scientific research on competitiveness and digital transformation are explained in the second section. Data and research methodology are described in the third section of the publication. The fourth section of the article presents the research results. Discussions are presented in the fifth section of the article. Conclusions are presented in the paper's sixth section.

2. LITERATURE REVIEW

Competitiveness and digital transformation have become two of the most popular topics in economic theory and policy in recent years. Despite the growing interest in competitiveness among the scientific community, the field of economics has not definitively demonstrated a coherent definition of competitiveness. This is typically due to the variety of its assessment as well as other related issues. According to Freudenberg (2003); Aghion *et al.* (2005); Snowdon and Stonehouse (2006); Berger and Bristow (2009); Terzić (2017); Bukowski *et al.* (2021) structure convergence and other restrictions that assess the significant interactions between the various aspects of the framework are the primary drivers of competitiveness, inventiveness, and prosperity.

García-Sánchez *et al.* (2019) indicate that the capacity of an economy to maximize the advantages generated by the worldwide transfer of labor and capital is known as its international competitiveness. Garelli (2006) defined competitiveness as a nation's capacity to attain steady growth in GDP per capita, which guarantees its citizens an adequate standard of living, being able to effectively perform specific jobs, and a decrease in unemployment. The scientific literature offers numerous definitions of competitiveness as an economic phenomenon associated with a country's socioeconomic progress (Fagerberg *et al.*, 2007; Aiginger and Schratzenstaller, 2016). Lollar *et al.* (2010) emphasized the role of technology in fostering competitiveness.

Neo-Schumpeterian (Schumpeter, 1934) and neoclassical growth doctrines (Solow, 1956) are two well-known contemporary theories that propose positive connections between technological innovation, technological readiness, technological diffusion, and the overall economic climate. According to Sui *et al.* (2024), digital transformation boosts manufacturing organizations' level of competitiveness by increasing human capital, research and development effectiveness, and efficiency of all factors. Adoption of digital technology and levels of digital competitiveness between European countries are significantly correlated (Martinčević, 2022). Additionally, digitalization is essential for eco-innovation and sustainability (Xu *et al.*, 2024).

The process of reimagining a company in order to fulfill market expectations through the use of digital technologies is known as "digital transformation." The term "digital readiness" describes how ready a company is to embrace and use digital technology, with an emphasis on the fundamental infrastructure, competencies, and resources required to begin digital transformation (Soomro *et al.*, 2020; Verhoef *et al.*, 2021). The International Institute for Management Development (IMD) World Competitiveness Index, which takes into consideration the four main groups of variables that affect an economy's level of competitiveness, applying each category separated into five subdivisions that emphasize different facets of competitiveness, offers a broad overview of the variables that influence an economy's degree of competitiveness. Schwab (2017) asserts that competitiveness has a significant impact on national economies, particularly on their capacity for innovation, finances, institutions, infrastructure, stable macroeconomics, and economic development.

Economists Solow (1956) and Romer (1990) laid the theoretical groundwork for the answers to the problems of why certain nations are more inventive, competitive, and faster-growing than others, but they left out some important details. Competitiveness, innovation, and other national outcomes have drawn the attention of many academics in recent years (Cho and Moon, 2000; Malerba and Brusoni, 2007; Porter, 2008; Carrillo-Hermosilla *et al.*, 2009; Foray, 2009; Atkinson and Ezell, 2012; Edquist, 2016; Terzić, 2017; Bukowski *et al.*, 2021; Hermundsdottir and Aspelund, 2021).

They highlighted various perspectives and elements affecting a nation's ability to compete, innovate, or prosper economically. Rozmahel *et al.* (2014) highlight the infrastructure-based competitiveness assessment of EU member states. The potential to improve one's competitive position is represented by the phenomenon known as national competitiveness. "Competitiveness" has two meanings. Competition has become the primary aspect, and competence – the ability to compete effectively on a national or worldwide scale – is the second aspect.

According to Browne *et al.* (2016), creative and competitive performances affect impressive economic results that impact a particular sector's competitiveness or national competitiveness. The academic and government institutions are becoming increasingly interested in the subject of digital transformation issues. In order to provide policymakers with more information about the status and direction of digital transitions worldwide, composite analytical indices have become a valuable group of indicators.

As an essential tool for decision-makers, the World Digital Competitiveness Index aims to be a comprehensive, worldwide indicator that monitors the efficiency of digital systems at the national level. Additionally, it takes into account knowledge, technology, and future readiness that provide favorable circumstances for a successful digital transition. In this approach, the WDCI makes it possible to comprehend the current and historical conditions of the global digital competitiveness transition, which results in better-informed investment and decisions regarding governmental policy. Higher levels of transparency and a reliable comprehension of the digital transition's development are therefore necessary, as it has become a crucial policy concern and a commercial concern.

In addition to the ambitious goal of thoroughly monitoring the global digital competitiveness and digital transformation, the IMD created the WDCI methodology. An analytical framework that gauges transition as a move toward a digital system that promotes digital competitiveness, sustainability, reliability, and accessibility, as well as toward organizations that facilitate this efficiency, constitutes the core of the Index. There are various definitions and metrics for digital readiness due to the variety of governance systems and mutual dependence across distribution networks and commerce. There is consensus about the wider socio-economic and political aspects of digital transition. However, other studies define it as a change of current technological innovation (Fagerberg and Godinho, 2004; Porter, 2008; Ganotakis and Love, 2011; Castellacci and Natera, 2015; Dorrego *et al.*, 2024).

A rapid transformation to a more economical, viable, and accessible digital system that offers answers to the world's digital transition-associated problems is part of an efficient and knowledge-based competitiveness. Without jeopardizing the equilibrium of the three crucial digital system performance areas that collectively comprise the digital competitiveness framework, it opens possibilities for business and society. The IMD's World Digital Competitiveness Index (IMD, 2025c) is an aggregate measure that combines parameters with identical weights implemented according to hierarchy, covering the most significant elements

across various aspects of three fundamental pillars: knowledge, technology, and future readiness. Table no. 1 presents the definition of the indices used in the study (the World Competitiveness Index, Digital Transformation Index, Government Efficiency Index, Business Efficiency Index, Infrastructure Index, World Digital Competitiveness Index, Knowledge Index, Technology Index, and Future Readiness Index).

Table no. 1 - Definition of competitiveness and digital transformation indices used in the study

Indices	Definition
WCI	The World Competitiveness Index (WCI) evaluates a country's capacity to establish and preserve a sustainable business environment. WCI includes four pillars: economic performance, government efficiency, business efficiency, and infrastructure.
DTI	The digital transformation index (DTI) demonstrates how the economy's major economic sectors are addressing the issue of digitization, highlighting advancements, obstacles, and possibilities. It also shows how digitalization has developed into a strategic force that can change organizational cultures and ways of doing business.
GEI	Government efficiency index (GEI): the degree to which competitiveness initiatives are supported by the government policies including public spending, tax legislation, organizational framework, enterprise legislation, and social systems.
BEI	Business efficiency index (BEI): the degree to which the national environment promotes innovative, profitable, and ethical business practices. BEI includes the following: labor market conditions, created values, management skills, standards, and ethics.
INF	Infrastructure index (INF): how well the company's requests are fulfilled by its essential, technology-related, scientific, and human resources. INF includes fundamental infrastructure, technological infrastructure, infrastructure for knowledge creation, health protection, environment, and learning systems.
WDCI	The World Digital Competitiveness Index (WDCI) emphasizes innovation, human capital, and future readiness, focusing on knowledge-driven competitiveness.
KI	The knowledge index (KI) includes intangible infrastructure necessary for discovering, comprehending, and creating new technologies (talent, training and education, and scientific concentration).
TI	Technology index (TI): the broader framework associated with dimensions of technology that ensures development of digital technologies (regulatory environment, capital, and technological skills).
FRI	The future readiness index (FRI) is examining the level of preparedness of the economy for the digital transformation (flexible viewpoints, business agility, and integration of the IT sector).

Source: Derived from IMD World Competitiveness Booklet 2025 (IMD, 2025b), IMD World Digital Competitiveness Rankings 2025 (IMD, 2025c).

The significance of digital infrastructure, environments for innovation, and technological adaptability as crucial factors influencing socioeconomic and financial outcomes is being emphasized in increasing numbers by academics and organizations. The indices examined in this research, which together offer a multifaceted view of digital competitiveness, also represent these elements: WCI, DTI, BEI, INF, WDCI, KI, TI, and FRI. The aforementioned indices constitute some of the most popular metrics for assessing a nation's digital competitiveness, which is why they were selected for this study.

Complex scientific, economic, and sociopolitical variables are driving the digital competitiveness in the Eastern European countries. The connection between initiatives to conduct digital transformation, especially in the industrial sector, should be taken into

consideration in a cohesive policy strategy. Reliable governing circumstances and efficient use of EU funding should be given top priority under the comprehensive policy regulations. In the past, product differentiation, economies of scale, and cost effectiveness have all been key components of competitiveness. Nevertheless, as the digital economy has developed, the competitive environment has changed by putting more emphasis on knowledge-based elements, including human resources, intellectual capital, the image of the company, and the ability to innovate. The idea of competitiveness has been progressively extended by digital transformation. Companies must incorporate digital technologies throughout their fundamental operations in order to stay competitive. It is difficult to compete in the modern world without utilizing new digital technology. Global digital competitiveness is increased by the digital economy and cutting-edge technology that accelerate social and economic change.

Numerous well-established indices that gauge various aspects of a country's preparedness and capacity to use digital technology can be used to evaluate a nation's digital competitiveness. Every one of the parameters is divided into four categories: infrastructure, business efficiency, government efficiency, and economic performance. Every factor is divided into five sub-factors. These sub-factors do not always have an identical set of factors, as, for example, evaluating the education sub-factor requires more criteria than evaluating the prices sub-factor. Each sub-factor has a weight of 5% (20 x 5 = 100) in the overall aggregation of findings, regardless of how many criteria they comprise. Knowledge, technology, and future readiness are the three primary components of digital competitiveness, according to the World Digital Competitiveness Rankings (WDCR) methodology. Each one of those components is subsequently separated down into three components; each one of them highlights a different aspect of the areas under analysis.

3. RESEARCH METHODOLOGY AND DATA

The International Institute for Management Development (IMD) developed the World Competitiveness Index (WCI), which provides a data-driven evaluation of overall competitiveness. The IMD World Competitiveness Index includes four dimensions of national competitiveness: the economic performance index, the government efficiency index, the business efficiency index, and the infrastructure index (IMD, 2025b). The IMD World Competitiveness Yearbook is a thorough yearly report that serves as a global standard for evaluating national competitiveness. In addition to metrics and research findings derived from in-depth study, it offers comparative analysis and overall patterns. In order to accomplish generating value over time, it assesses and ranks nations based on how they effectively govern their capabilities.

The model was based on an integrated theory of both technology-driven and endogenous growth (Romer, 1990). Such concepts have been used in the study to emphasize the importance of national rankings based on competitiveness, technological effectiveness, and knowledge. Effective companies should produce final goods that could be used to create intermediate goods or goods of higher quality with a new technology application.

Thus, a new technology indicator could be presented using the following equation:

$$Indicator = \int_0^g X_i^{\alpha} \left(Y_i^{\alpha} Y^{1-\alpha} \frac{Sd^{\beta} \mathrm{Re}^{1-\beta}}{g^{1-\delta}}\right)^{1-\delta} x_i \qquad 0<\alpha, \beta; \delta<1 \tag{1}$$

Where: g is the indicator of intermediate goods, Sd indicates digital skills, and Re represents efficient resources. The indicators for observed countries could be calculated using the formula below:

$$i = DTI_i C_i^{\alpha} Sd_i^{\beta} \mathrm{Re}_i^{1-\alpha-\beta} \quad 0<\alpha<1;0<\beta<1 \tag{2}$$

$$DTI_i = DTI^{\beta} C_{DTI}^{\beta} Sd_{DTI}^{\beta} \mathrm{Re}_{DTI}^{1-\beta-\delta} \quad 0<\beta<1;\delta<1 \tag{3}$$

where:

- The quantity of metrics utilized in knowledge creation is represented by the variable i.
- C displays the capital used to create knowledge,
- Sd signifies digital skills,
- Re refers to efficient resources, and
- Digital Transformation Index (DTI) denotes the set of indicators regarding the digital transformation initiatives developed in the R&D sector of companies in Eastern European countries.

In order to verify the indicators' aggregation with many dimensions, each DTI-monitored parameter has been transformed into "grades of achievement", which categorize countries from 0 to 10 (with the highest conceivable and the lowest tolerable digital transformation performance scores). Therefore, each parameter is typically scaled again using the following formula to determine the total WDCI score:

$$Normalized\ score = \frac{Country\ value - Minimum}{Sample\ maximum - Sample\ minimum} * 100 \tag{4}$$

Based on an extensive study of economic publications from international, national, and local databases, as well as input from the business sector, government organizations, and economists, 334 competitiveness parameters were chosen to create the World Competitiveness Ranking. As new theories, investigations, and data become available, as well as the world economy changes, the criteria are routinely evaluated and revised (Garelli, 2006; Tusińska, 2016; Terzić, 2017). To increase the uniformity and impartiality of the WCR Index structure, the IMD is making modifications. Globally, policymakers and scholars will be able to extract more relevant and important suggestions to improve or fully disclose the competitive advantages of the states under observation. Spearman's analysis of hypotheses has been employed to investigate the associations between significant variables.

The comparative analysis also examined the significance of Spearman's relationships using the rho-p test for hypotheses, which is frequently conducted on ordinal variables. The relationships between the World Competitiveness Index, Digital Transformation Index, Government Efficiency Index, Business Efficiency Index, Infrastructure Index, World Digital Competitiveness Index, Knowledge Index, Technology Index, and Future Readiness Index were investigated employing Spearman's rank-order correlations. Knowledge, technology,

and future readiness are the three primary components of digital competitiveness according to the WDCR methodology. Each of these elements is subsequently divided into three sub-factors, each of which highlights a different aspect of the areas under analysis. Every sub-factor has the same relevance in the total aggregation of findings. Three sub-indices are weighted and averaged to determine the WDCI score. The numerous parameters of the index serve as the foundation for each sub-index, which is the arithmetic average across its constituent dimensions.

The most recent data available at the time of collection is reflected in the WDCI 2025 results. The WDCI score is measured on a scale of 0 to 100, with 100 being the highest attainable score and 0 being the lowest. Each indicator, except the indicator of digital transformation in companies, is standardized to the 0–100 scale, employing a minimum-maximum approach to enable comparison and aggregation. The indicator of digital transformation in companies is standardized to the 0–10 scale, employing a minimum-maximum approach to assure aggregation.

The lowest and greatest values for nations covered by the WDCI are represented by the sample's minimum and sample maximum. The analysis uses a normalizing procedure that not only converts the series to 0-100 and 0-10 but also modifies it so that 0 and 100, and 0 to 10, still represent the worst and best, correspondingly, for those parameters for which a larger raw value suggests a less favorable result. Data sources that were implemented to aggregate the indicators include the IMD World Competitiveness Report (IMD, 2025b), World Digital Competitiveness Report (IMD, 2025c), and IMD countries database (IMD, 2025a). This study benchmarks associations between competitiveness and digital transformation across Eastern European countries in 2025. Spearman's rank correlations on a longitudinal dataset and actual 2025 scores were employed in the analysis. The comparative analysis is restricted to descriptive associations but provides essential information for Eastern European comparisons and formulating hypotheses for future analyses on the relationship between competitiveness and digital transformation. Given the annual snapshot, results should not be interpreted as patterns or causal impacts. To be supplemented with a content analysis of the results obtained when applying statistical methods.

4. RESEARCH RESULTS

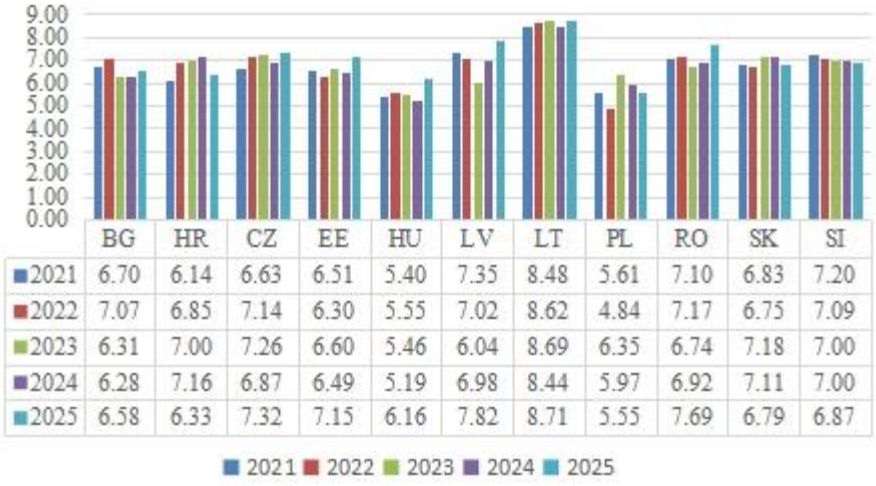
The research study was carried out in the following Eastern European countries: Czech Republic (CZ), Slovenia (SI), Estonia (EE), Latvia (LV), Lithuania (LT), Slovakia (SK), Croatia (HR), Romania (RO), Poland (PL), Hungary (HU), and Bulgaria (BG). The aggregated data for the Eastern European countries covers the period 2024–2025. Table no. 2 presents scores and ranks in the Eastern European countries based on the World Competitiveness Index (WCI), Digital Transformation Index (DTI), Government Efficiency Index (GEI), Business Efficiency Index (BEI), and Infrastructure Index (INF).

Table no. 2 - Scores and rankings of the Eastern European countries based on indicators of competitiveness and digital transformation for the 2024-2025 period

Country	WCI		DTI		GEI		BEI		INF	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
PL	53.91	8	5.09	7	36.88	10	17.41	8	46.83	7
CZ	73.66	2	6.24	3	63.28	1	57.25	3	60.42	2
SK	42.79	11	3.76	11	25.59	11	9.87	11	38.27	10
HU	56.71	6	5.04	8	44.09	6	21.81	7	53.19	5
LT	77.68	1	7.33	1	63.14	2	74.19	1	63.99	1
LV	67.03	4	6.59	2	56.54	4	54.87	4	58.32	4
EE	69.65	3	6.00	4	62.19	3	57.92	2	59.20	3
RO	56.64	7	5.91	5	44.78	5	38.46	5	43.63	8
SI	59.14	5	5.16	6	42.82	7	33.09	6	50.89	6
HR	51.19	9	4.81	9	38.39	9	16.50	9	39.43	9
BG	47.96	10	4.43	10	41.13	8	14.50	10	33.37	11

Source: Data from IMD (2025b), (IMD, 2025a), and the author's own calculations.

On the basis of the competitiveness and digital transformation scores and rankings compared to other analyzed economies for the studied period, Lithuania has achieved the best results. According to the World Competitiveness Index, Digital Transformation Index, Business Efficiency Index, and Infrastructure Index, Lithuania is the best-ranked economy. Slovakia is the worst-ranked economy according to the WCI, DTCI, GEI, and BEI compared to the observed Eastern European economies, while Bulgaria is the worst-positioned economy on the Infrastructure Index. The Czech Republic is the highest-ranked Eastern European country according to the Government Efficiency Index (GEI). Figure no. 1 below shows digital/ technological skills scores in Eastern European countries in the observed period (2021-2025).

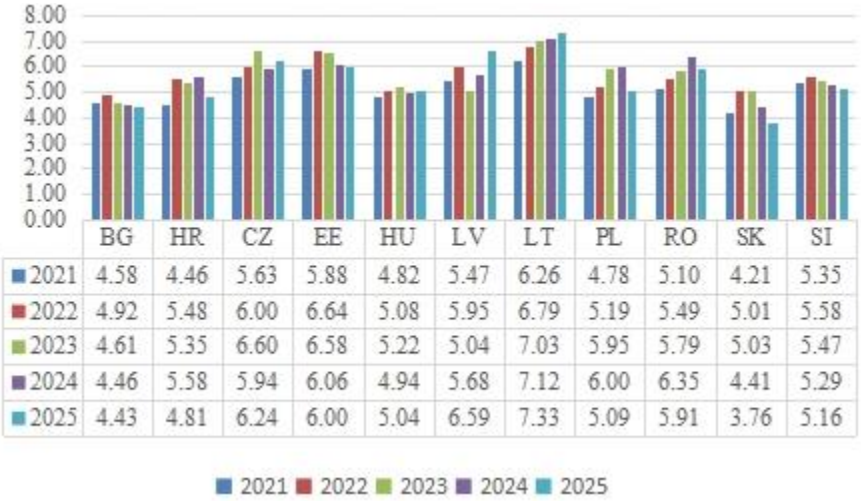


	BG	HR	CZ	EE	HU	LV	LT	PL	RO	SK	SI
2021	6.70	6.14	6.63	6.51	5.40	7.35	8.48	5.61	7.10	6.83	7.20
2022	7.07	6.85	7.14	6.30	5.55	7.02	8.62	4.84	7.17	6.75	7.09
2023	6.31	7.00	7.26	6.60	5.46	6.04	8.69	6.35	6.74	7.18	7.00
2024	6.28	7.16	6.87	6.49	5.19	6.98	8.44	5.97	6.92	7.11	7.00
2025	6.58	6.33	7.32	7.15	6.16	7.82	8.71	5.55	7.69	6.79	6.87

Source: author's own creation from the IMD country database, 2021-2025.

Figure no. 1 – Digital/Technological skills Index scores in Eastern European countries for the 2021-2025 period

As shown in Figure no. 1, Lithuania achieved the highest Digital/Technological Skills Index (DTSI) scores from 2021 to 2025. In 2021, and 2023, Hungary was the nation with the lowest DTSI index score. According to DTSI, Poland obtained the lowest score in 2022 and 2025. After Lithuania, Latvia has achieved the second-highest DTSI score (7.82) in 2025. A mix of government efforts, strategic infrastructure investments, and a dedication to digital transformation are responsible for Lithuania's accomplishments in digital/technological skills. The scores of the Eastern European countries based on digital transformation index scores for the years 2021–2025 are shown in Figure no. 2.



	BG	HR	CZ	EE	HU	LV	LT	PL	RO	SK	SI
2021	4.58	4.46	5.63	5.88	4.82	5.47	6.26	4.78	5.10	4.21	5.35
2022	4.92	5.48	6.00	6.64	5.08	5.95	6.79	5.19	5.49	5.01	5.58
2023	4.61	5.35	6.60	6.58	5.22	5.04	7.03	5.95	5.79	5.03	5.47
2024	4.46	5.58	5.94	6.06	4.94	5.68	7.12	6.00	6.35	4.41	5.29
2025	4.43	4.81	6.24	6.00	5.04	6.59	7.33	5.09	5.91	3.76	5.16

Source: author's own creation from the IMD country database, 2021-2025

Figure no. 2 – Digital Transformation Index scores in Eastern European countries for the 2021-2025 period

Lithuania achieved the highest Digital Transformations Index scores from 2021 to 2025 (6.26, 6.79, 7.03, 7.12, 7.33). According to the DTI index, Latvia had the second-highest score in 2025 (6.59). In 2021, 2024, and 2025, the Slovak Republic was the country with the lowest DTI index score. According to DTI, Bulgaria obtained the lowest score in 2022 and 2023. In addition to Lithuania, the Czech Republic and Estonia also scored highly in terms of corporate digital transformation. After Lithuania, Romania has the second-highest DTI score (6.35) in 2024. Through the assistance of a legal system that prioritizes transparency and stakeholder involvement, Lithuania has achieved notable progress in developing its digital transformation.

Regulatory impact evaluations, which are required to assess the possible social, environmental, and economic implications of new regulations, are part of the systematic process for establishing or eliminating restrictions. This guarantees that new rules are supported by knowledge and harmonized with national interests. During the process of creating regulations, the Lithuanian government frequently uses working groups and open discussions to interact with the commercial sector and other interested parties. The scores and rankings of the Eastern European nations based on digital competitiveness indicators for the years 2024–2025 are shown in Table no. 3.

Table no. 3 – Scores and rankings of the Eastern European countries based on indicators of digital competitiveness in 2024-2025

Country	WDCI		Knowledge Index		Technology Index		Future Readiness Index	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank
PL	60.22	6	58.10	6	54.34	8	50.07	7
CZ	71.06	4	65.40	4	64.82	5	64.82	4
SK	50.72	10	49.01	10	44.15	11	40.86	8
HU	60.14	7	55.88	7	65.65	4	40.75	10
LT	84.30	1	74.62	1	75.41	1	84.74	1
LV	74.87	3	62.62	5	70.50	2	73.35	3
EE	77.84	2	68.70	2	70.12	3	76.57	2
RO	59.39	8	50.71	9	57.76	7	51.56	6
SI	65.06	5	66.15	3	58.74	6	52.15	5
HR	55.18	9	52.51	8	54.04	9	40.84	9
BG	49.53	11	44.86	11	52.28	10	33.29	11

Source: data from IMD (2025c), IMD (2025a), and the author's own calculations

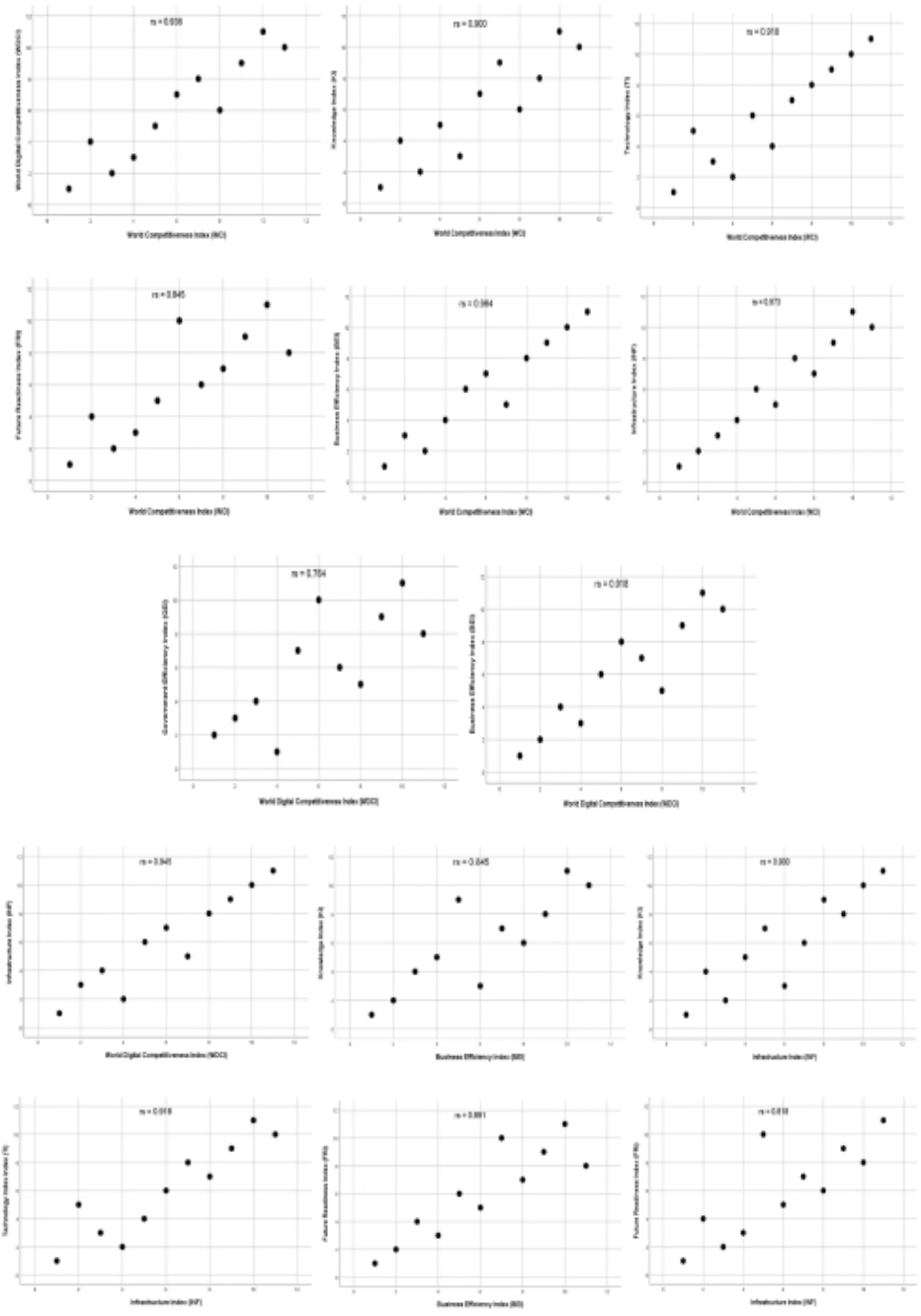
In the observed period, Lithuania achieved the highest position (1st ranked Eastern European country) in the following innovation indices: World Digital Competitiveness Index (WDCI), Knowledge Index (KI), Technology Index (TI), and Future Readiness Index (FRI). Estonia positioned as the second highest ranked Eastern European countries according to WDCI, KI, and FRI. Behind Lithuania, Latvia is the second ranked country according to the Technology Index. The correlations between the competitiveness and digital transformation variables in the observed Eastern European economies are displayed in Table no. 4. The statistical software program (SPSS 25) was used to carry out the empirical investigation.

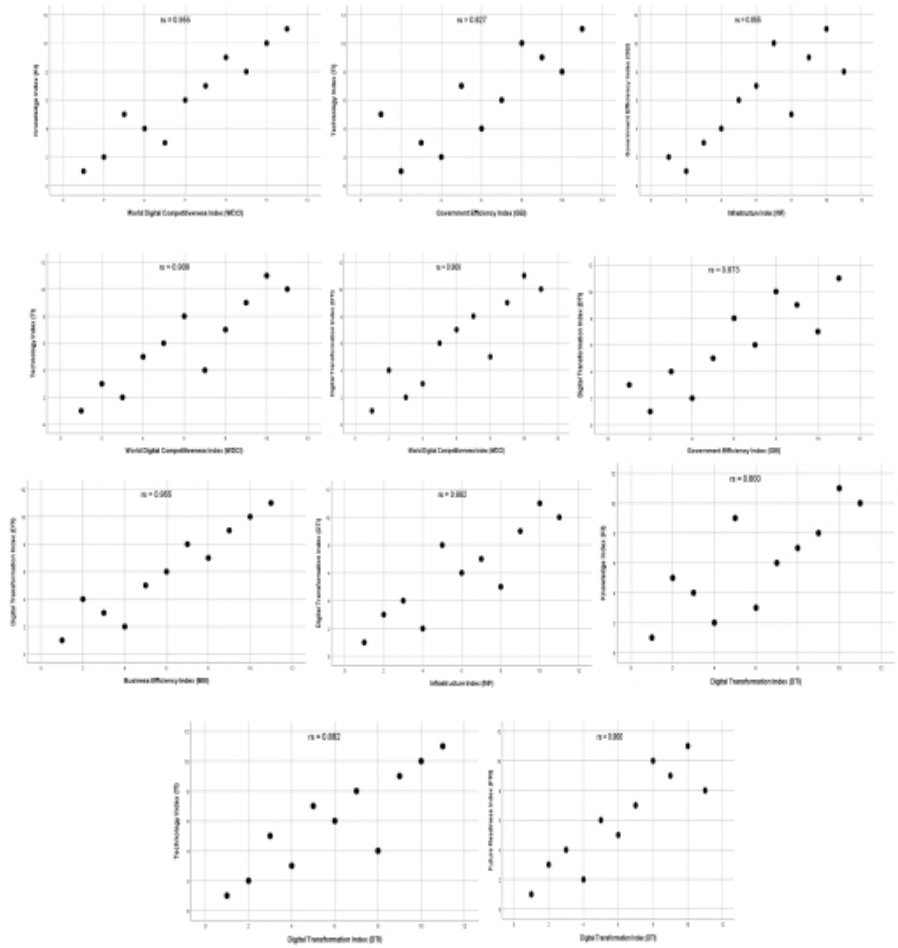
Table no. 4 – Correlation matrix of the competitiveness and digital transformation variables

	WCI	DTI	GEI	BEI	INF	WDCI	KI	TI	FRI
WCI	1.000	.927**	.918**	.964**	.973**	.936**	.900**	.918**	.845**
DTI	.927**	1.000	.873**	.955**	.882**	.909**	.800**	.882**	.900**
GEI	.918**	.873**	1.000	.927**	.855**	.764**	.673*	.827**	.727*
BEI	.964**	.955**	.927**	1.000	.918**	.918**	.845**	.900**	.891**
INF	.973**	.882**	.855**	.918**	1.000	.945**	.900**	.918**	.818**
WDCI	.936**	.909**	.764**	.918**	.945**	1.000	.955**	.909**	.918**
KI	.900**	.800**	.673*	.845**	.900**	.955	1.000	.818**	.855**
TI	.918**	.882**	.827**	.900**	.918**	.909	.818	1.000	.764**
FRI	.845**	.900**	.727*	.891**	.818**	.918	.855	.764	1.000

Note: **Correlation is significant at p<0.001 level. *Correlation is significant at p<0.005 level.
Source: author's own calculation

The following scatter plots show the Spearman's correlation coefficient results for Eastern European countries in 2024-2025.





Source: created by the author using SPSS 25

Figure no. 3 – Scatterplots presenting the relationships between the competitiveness and digital transformation indicators for Eastern European countries in 2024-2025

The Spearman's rank-order correlations were run to examine the relationship between WCI, DTI, GEI, BEI, INF, WDCI, KI, TI, and FRI. There are positive and significant correlations between WCI and WDCI, rs=.936 p<0.001; WCI and KI, rs=.900 p<0.001; WCI and TI, rs=.918 p<0.001; WCI and FRI, rs=.845 p<0.001; WCI and BEI, rs=.964 p<0.001; WCI and INF, rs=.973 p<0.001; WDCI and GEI, rs=.764 p<0.001; WDCI and BEI, rs=.918 p<0.001; WDCI and INF, rs=.945 p<0.001; BEI and KI, rs=.845 p<0.001; KI and INF, rs=.900 p<0.001; TI and INF, rs=.918 p<0.001; FRI and BEI, rs=.891 p<0.001; FRI and INF, rs=.818 p<0.001; WDCI and KI, rs=.955 p<0.001; GEI and TI, rs=.827 p<0.001; INF and GEI, rs=.855 p<0.001; WDCI and TI, rs=.909 p<0.001; DTI and WDCI, rs=.909 p<0.001; DTI and GEI, rs=.873 p<0.001; BEI and DTI, rs=.955 p<0.001; INF and DTI, rs=.882 p<0.001; DTI and KI, rs=.800 p<0.001; DTI and TI, rs=.882 p<0.001; DTI and FRI, rs=.900 p<0.001.

5. DISCUSSIONS

The study's findings represent substantial evidence of consistency as well as reliability of the rankings obtained from the chosen competitiveness, digital competitiveness and digital transformation indices. According to the investigation, rankings based on the WCI, DTI, GEI, BEI, INF, WDCI, KI, TI, and FRI show a high degree of compatibility. This is especially evident in the scores and Spearman's coefficient values. According to Spearman's rank-order correlation coefficient, rs=.936, p<0.001, the first scatter diagram in Figure 3 demonstrates a very strong positive and significant relationship between WCI and WDCI. The positive correlation coefficient (0.936**) between WCI and WDCI shows that infrastructure, corporate efficiency, and government efficiency all reflect national competitiveness, which is crucial for digital competitiveness.

The second scatter diagram in Figure 3 shows a very high positive interlinkage between WCI and KI (0.900**). The development, dissemination, and use of knowledge are crucial for increasing national competitiveness and digitalization, according to a positive correlation between WCI and KI. The correlation coefficient rs=.918, p<0.001, as shown in the third scatter plot in Figure 3, indicates a very strong positive link between WCI and TI. The regulatory framework, capital, and technological skills all reflect the importance of digital technologies for national competitiveness, as evidenced by the positive correlation coefficient between WCI and TI (0.918**).

The competitiveness based on government efficiency, corporate efficiency, and infrastructure is crucial for future digital readiness, evidenced by the positive correlation coefficient between WCI and FRI (0.845**). According to Spearman's rank-order correlation coefficient (rs=.964, p<0.001), there was a very high positive relationship between WCI and BEI. The significance of business efficiency for boosting national competitiveness is demonstrated by the positive correlation coefficient (0.964**) between WCI and BEI. Spearman's rank-order correlation coefficient (rs=.973, p<0.001) indicated that WCI and INF had a very strong positive association. Infrastructure, as determined by basic infrastructure, technological infrastructure, infrastructure for knowledge creation, health protection, the environment, and learning systems, is crucial for national competitiveness, according to the positive correlation coefficient between WCI and INF (0.973**).

The significance of government efficiency for digital competitiveness is demonstrated by the positive correlation coefficient (0.764**) between WDCI and GEI. Spearman's rank-order correlation coefficient (rs=.918, p<0.001) indicated the very high positive interlinkage between WDCI and BEI. Business efficiency is essential for digital competitiveness, according to the positive correlation coefficient (0.918**) between WDCI and BEI. Spearman's rank-order correlation coefficient (rs=.945, p<0.001) indicated the very high positive interlinkage between WDCI and INF. The significance of infrastructure development for digital competitiveness is demonstrated by the positive correlation coefficient (0.945**) between WDCI and INF.

The significance of knowledge for business efficiency is demonstrated by the positive correlation coefficient (0.845**) between BEI and KI. The significance of digital infrastructure for knowledge creation, dissemination, and application is indicated by a substantial positive correlation (0.900**) between KI and INF. The significance of technology for the development of digital infrastructure is indicated by the positive correlation coefficient

(0.918**) between TI and INF. FRI and BEI showed a very strong positive correlation (0.891**), indicating the importance of company efficiency for future digital readiness.

Spearman's rank-order correlation coefficient, rs=.818, p<0.001, confirmed the very strong positive association between FRI and INF. The significance of digital infrastructure for national economies' future digital preparedness is indicated by the positive correlation coefficient between FRI and INF (0.818**). Spearman's rank-order correlation coefficient (rs=.955, p<0.001) indicated a very strong positive association between WDCI and KI. The significance of knowledge generation, dissemination, and application for digital competitiveness is indicated by a substantial positive correlation (0.955**) between WDCI and KI. The significance of technology for government efficiency is demonstrated by the positive correlation coefficient (0.827**) between GEI and TI. Spearman's rank-order correlation coefficient (rs=.855, p<0.001) indicated a very strong positive association between INF and GEI**.**

Digital infrastructure is essential for government efficiency, according to the positive correlation coefficient (0.855**) between INF and GEI. The significance of technology for digital competitiveness is demonstrated by the very significant positive interlinkage between WDCI and TI (0.909**). The significance of digital transformation for digital competitiveness is demonstrated by the substantial positive correlation coefficient (0.909**) between DTI and WDCI. Spearman's rank-order correlation coefficient, rs=.873, p<0.001, indicated a very significant positive interlinkage between DTI and GEI, indicating that governance efficiency is critical for digital transformation.

Spearman's rank-order correlation coefficient, rs=.955, p<0.001, revealed that BEI and DTI had a very strong positive association. The significance of business efficiency for digital transformation is indicated by the strong positive correlation (0.955**) between BEI and DTI. The significance of digital infrastructure for digital transformation is indicated by the positive correlation coefficient (0.882**) between INF and DTI. According to Spearman's rank-order correlation coefficient, rs=.800, p<0.001, there was a very substantial positive association between DTI and KI. The significance of knowledge production, dissemination, and application for digital transformation is indicated by the substantial positive correlation between WDCI and KI (0.800**). The significance of technology for digital transformation is demonstrated by the substantial positive correlation coefficient (0.882**) between DTI and TI. Spearman's rank-order correlation coefficient, rs=.900, p<0.001, indicated that there was a very strong positive association between DTI and FRI. The significance of digital transformation for future digital preparedness is indicated by the substantial positive correlation (0.900**) between DTI and FRI.

These results support the claim that the relative positions of nations in an environment of digital competition, particularly between the highest-ranked and lowest-ranked nations, remain surprisingly consistent regardless of methodological variations. The findings are consistent with a deeper understanding of the role that digital skills play in boosting national competitiveness. For example, Sui *et al.* (2024) and Martinčević (2022) noted that industrial companies' competitiveness is positively impacted by digital transformation and that digitalization-driven competitiveness has become a tool to boost resilient economies, lower costs, and increase productivity.

The integration of country rankings across different indices supports the claim that adequate digital infrastructure, future readiness, and digital quality based on sufficient knowledge are essential elements of competitiveness, as acknowledged by various international governing bodies. According to this, nations like Lithuania, Latvia, and Estonia

are among the top-ranked in every index, which is indicative of their acknowledged capabilities in digital infrastructure, environments for innovation, and strategic approach toward digital technology.

These findings are consistent with those of Venkatraman (2017), who recognized certain nations as digital innovators because of their capacity for innovation and development of digital infrastructure. Ashmarina *et al.* (2020) results, which emphasize the importance of institutional encouragement and adequately developed digital infrastructures in attaining high competitiveness rankings, reinforce this concept. However, according to the study findings, nations like Bulgaria and Slovakia routinely score lower on almost every index. In general, by offering an analysis of indicators and confirming their dependability, this investigation contributes to the continuing discussion on digital competitiveness. A significant degree of consensus regarding the relative digital competitiveness of nations is suggested by the consistent results across the majority of indicators. Nonetheless, the differences observed in particular indices emphasize how crucial it is to have a multifaceted strategy in order to fully assess and comprehend digital competitiveness.

6. CONCLUSIONS

The primary objective of this article was to examine the influence of digital transformation on the competitiveness of the Eastern European countries. Different methodological approaches have been used in regard to the stated goal of investigating the relationships between competitiveness and digital transformation indicators. The research results have indicated very strong positive and significant correlations between the WCI, DTI, GEI, BEI, INF, WDCI, KI, TI, and FRI. Designating the determined significant correlations, it could be concluded that Eastern European countries' competitiveness is influenced by digital transformation that relies upon the WDCI pillars as follows: knowledge, technology, and future readiness. The research results also indicate that the digital competitiveness of observed countries is influenced by the following WDC pillars: digital transformation in companies, government efficiency, business efficiency, and infrastructure.

The competitiveness and digital transformation scores and rankings provided by the key indicators can be crucial for comparative analysis between countries and offer useful suggestions to policy creators in order to achieve a prosperous future and the objectives of the digital competitiveness policies of Eastern European countries. Eastern European countries and their companies are well-positioned to adopt the new technology solutions needed to sustain digital competitiveness throughout Europe as well as worldwide. This paper contributes by assuring new theoretical perception and empirical research on the relationship between competitiveness and digital transformation indicators in Eastern European countries. Additionally, the conducted comparative analysis guarantees a newly collected, comprehensive dataset that may be utilized for additional empirical research on countries' competitiveness, digital competitiveness, and digital transformation. The study provides insights into the literature that aims to gauge economies' competitiveness and digital transformation. The findings of the study have significant policy ramifications. In addition, improving the expected theoretical foundation for appropriate new economic policy in the Eastern European countries' investigations could be beneficial to provide an essential framework for acknowledging the significance of competitiveness and digital transformation variables in fostering digital transition.

The paper offers a new perspective by adapting Paul Romer's theory to the contemporary digital landscape of Eastern Europe, providing distinct theoretical insights and empirical research on the relationship between competitiveness and digitalization. Core originality lies in the adapted formula of the technological indicator, which integrates digital skills and efficient resources. Competitiveness and digital transformation indicators could provide valuable insights into business and government efficiency at the national level, accompanied by qualitative data or national policy recommendations. A more comprehensive look of industrial sector, government administration, health services, and educational opportunities could advance future knowledge of digital transformation and resource efficiency, as well as formulation of evidence-driven competitiveness policies. Future studies can also include the regular evaluation of the long-term viability and dependability of national rankings throughout indices. The data collected variability from year to year in certain rankings indicates that benchmark-based assessments could be influenced by methodological adjustments, indicator weights changes, or additional policy alterations, even if results show a high level of consistency.

ORCID

Lejla Terzić https://orcid.org/0000-0002-5048-036X

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