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DRIVING FACTORS OF THE DIGITAL ECONOMY – HOW COUNTRIES CAN MANAGE THEIR DIGITAL DEVELOPMENT

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Abstract: The digital economy and technologies play a key role in increasing the competitiveness of countries. This study aims to quantify the impact of selected socioeconomic indicators on the Digital Economy and Society Index (DESI) and its dimensions to find driving factors of the digital economy. The literature review used an approach based on the bibliometric meta-analysis as visualization tool. Panel data regression modelling was used for the analysis. This study found socioeconomic indicators that can improve the position of a country in DESI. The most significant changes are in the case of research and development expenditure. The results point to the economic and social connections of improving digitalization as strategic managerial implications for policies. The novelty of the study is that it points to economic indicators that impact the improvement of the DESI index and positively affect the future development of the country's digital economy.

Key words: DESI, digital skilled labor, socioeconomic indicators, R and D expenditure, human capital

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Introduction

The present time is characteristic of the main focus is on digitizing, where social development to new technologies and globalization processes push the economy to be changed (Stavytskyy et al., 2019). Technological innovation is a key driver of economic growth, and Industry 4.0 and related automation and digitalization

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significantly impact competition between countries and companies. So digitalization has become a mega trend in the country's economy (Štefko et al., 2021).
Since 2014, the European Commission has been monitoring the progress and level of development of Europe's digital competitiveness in each Member State through the Digital Economy and Society Index (DESI). From 2022, DESI summarises Europe's performance across the four dimensions of the Digital Decade policy programme: digital skills, digital infrastructure, digitalisation of business and public services, and monitoring and using progress in achieving digital goals (European Commission, 2022).
Monitoring and striving to progress DESI is necessary for many reasons. For example, the results of Le Thanh's (2022) study indicate that digitalization, especially the use of the internet and digital public services, reduced the prevalence of corruption in European countries. However, the effect of digital transformation only appears in the long run. Notably, the authors highlight the importance of online administrative procedures in combating corruption, especially during the COVID-19 pandemic. According to Vasyltsiv et al. (2022), the economy of digitalization requires effective government regulation and support, the mechanisms and tools of which shall be developed by the current conditions of the digitalization environment through identifying appropriate incentives. The introduction of digital technologies affects most socioeconomic and economic processes and activities, from agriculture to public services (Volkova et al., 2021).
This study aims to evaluate the relationship between selected socioeconomic indicators and the Digital Economy and Society Index (DESI) and its dimensions. Additionally, it seeks to quantify the impact of these indicators to identify the driving factors and potential risks affecting the digital economy. The presented study's benefit is that it points to economic indicators that impact the improvement of the DESI index and, at the same time, have a positive effect on the future development of the country's digital economy and the improvement of its competitiveness. In our opinion, panel data regression modelling with selected actual socioeconomic indicators and linking to DESI score and the use of our bibliometric meta-analysis approach to search for relevant scientific literature through bibliometric networks can help fulfil the research gap in this area of research and connect the international experience and policy recommendations for digital competitiveness.

Literature Review

The digital economy has become a widely examined topic as the world is now transitioning to digital, especially in COVID-19 times (Skvarciany et al., 2023). Stopping or reducing economic activities in traditional business subjects puts countries with a sufficiently prepared digital infrastructure, established digital technologies, and a prepared qualification base at a significant advantage (Liu, 2022). Digitalization, and digital transformation represent one of the primary incentives of today's development (Rakićević et al., 2017). Digital economy refers to the economic model that takes digital technology as the core to drive economic

activity and create benefits. In the future, all economic links may be driven by digital technology, which will be the driving force for world economic development and the engine for economic growth (Feng et al., 2019).

The digital economy can be defined in a narrow or broad sense. The narrow definition refers to the ICT sector only, including telecommunication, internet, IT services, hardware, software, etc. The broad definition includes the ICT sector, which is part of traditional sectors that have been integrated with digital technology. G20 uses this broad concept and defines the digital economy as "a broad range of economic activities that includes digitized information and knowledge as the key factor of production, and modern information networks as the important activity space" (Imran et al., 2022). The digital economy is understood as the use of information and communication technologies (ICT) by the state, business, and society (Moroz, 2017).

Vasyltsiv et al. (2022) discuss the term digital transformation and define it as the widespread introduction of digital technologies in all spheres of public life and economic relations, which are critical milestones in developing the world economy. As data visualization tools, for initial bibliometric mapping dimensions were harnessed, together with layout algorithms provided by VOSviewer concerning co-authorship (Figure 1, on the left), co-occurrence (Figure 2), and bibliographic coupling of documents (Figure 1, on the right) in combination with the WOS bibliographic data tool to investigate the keyword "digital economy and society index". Such an analysis was also used in the study by the authors Otola and Knop (2023). As a result, we obtained 356 documents in the Web of Science database for 2004-2023, mostly in Economics (27 documents), Business and Management (63 and 44 documents), and Environmental Sciences (33 documents). The selection parameters of the bibliometric meta-analysis are shown in Table 1.

Table 1. The selection parameters of the bibliometric meta-analysis

Search keywords in WOS: digital economy and society index		
co-authorship	co-occurrence unit of analysis: all keywords (author and keywords plus)	bibliographic coupling unit of analysis: documents
minimum number of documents of an author: 2	minimum number of occurrences keywords: 2	minimum number of citations of a document: 1
of the 1142 authors, 57 meet the thresholds	of the 1739 keywords, 313 meet the threshold	of the 356 documents, 247 meet the threshold

Source: Own elaboration

Note: The largest set of connected items, according to bibliographic coupling, consists of 164 items (some of the 247 items were not connected), so Figure 1 on the right shows this largest set instead of all items.

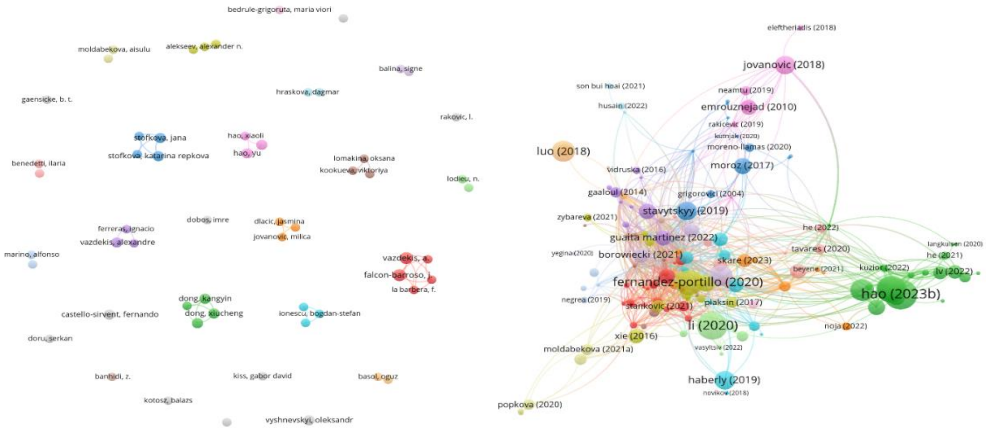

Figure 1: VOSviewer mapping of the digital economy and society index regarding co-authorship (left) and bibliographic coupling (right)
Source: Own elaboration

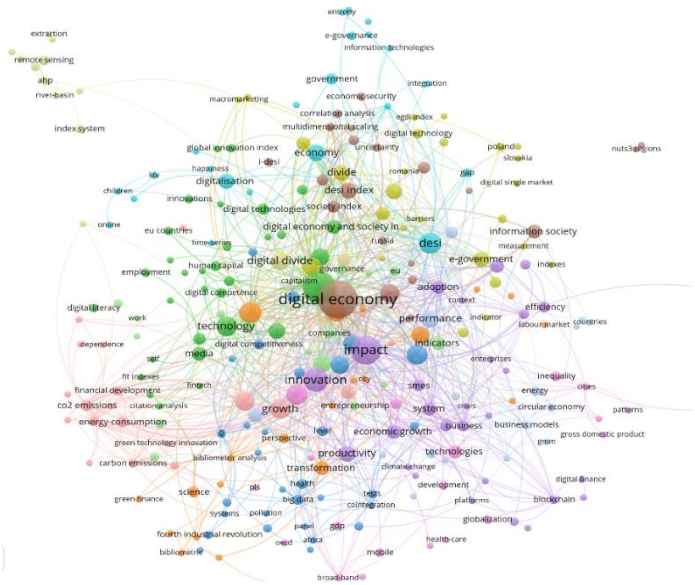

Figure 2: VOSviewer mapping of the digital economy and society index regarding co-occurrence
Source: Own elaboration

As shown in Figures 1-2, several studies and authors are devoted to digital transformation and DESI research.

Several studies focus on assessing the current state and forecasting the future development of digital competitiveness in countries compared to other EU member states, e.g. in Slovakia (Pekarčíková et al., 2021), Ukraine (Vasyltsiv et al., 2022),

Greece (Laitsou et al., 2020), Romania (Pînzaru et al., 2017; Androniceanu, Georgescu, 2023), Turkey (Yilmaz, 2021) and Republic of Croatia (Jurčević et al., 2020). Studies that analyze the outputs of the DESI index, i.e., the ranking or development of countries, are the most common. The authors focus only on the country's position or the set of countries in the given index.

It is also possible to find several studies dealing with the relationship between DESI and other indices, e.g.World Digital Competitiveness Ranking (Jurčević et al., 2020), Networked Readiness Index (Moroz, 2017), Global Innovation Index (Ionescu et al., 2022), Global Competitiveness Index, Digital Readiness Score, Knowledge Economic Index, The European Innovation Scoreboard, Bloomberg Innovation Index, The International Innovation Index and Global Innovation Index (Tiutiunyk et al., 2020; Nagy, Somosi, 2022).

The relationship between DESI and selected indicators is discussed in several studies. Tao, Wang, and Li (2023) examine the impact of the digital economy on public psychological resilience. Ren et al. (2022) explore the influence of digital economy agglomeration on inclusive green growth. Başol and Yalçın (2021) analyze the effect of DESI on labor market indicators. These and other studies highlight the diverse impacts of the digital economy. However, these authors primarily focus on determining the impact of DESI and its dimensions on the selected indicators. The presented article, on the other hand, focuses on which economic indicators influence the DESI index and thus contribute to a better digitization transformation and, ultimately, to a better competitiveness of the country.

Several authors emphasized the different factors that contribute to enhancing digitization processes. Toader et al. (2018) elaborated a study to identify and evaluate the effectiveness of using ICT infrastructure on economic growth in the European Union (EU) countries. However, the benefits of digital civilization do not always positively impact human life. In the race for scientific discoveries, innovations, and breakthrough technologies, States often forget about the social side of the digital economy: human comfort, health, safety, and satisfaction with the quality of life (Karpunina et al., 2019).

Methodological Approach

The main idea of this study is to evaluate the relationship and quantify the impact of selected socioeconomic indicators on DESI and its dimensions to find driving factors and risks of the digital economy. Based on the international research findings, approaches, experience and aim of this work, we set the following hypotheses:

- H1: A higher level of GDP (i.e., economic development) increases the level of digital development of the economy and society (DESI value).
- H2: A higher level of unemployment leads to a decrease in the digital development of the economy and society (DESI value).
- H3: Higher expenditure on education stimulates the country's digital development.
- H4: Higher research and development expenditure increases the level of digital development of the economy and society (DESI value).

The DESI index consists of four main indicators subdivided into three levels. Four indicators are located at the first level: Human Capital, Connectivity, Integration of Digital Technology, and Digital Public Services. At the second and third levels, these four indicators are specified and divided into 10 sub-dimensions on the second level and 32 indicators on the third level, as seen in Table 2 (European Commission, 2022).

Table 2. Structure of DESI, Indicators and Their Significance

Dimension	Sub-dimension	Indicator
Human Capital	Internet user skills	**At least basic digital skills**
		Above basic digital skills
		At least basic digital content creation skills
	Advanced skills and development	**ICT specialists**
		Female ICT specialists
		Enterprises providing ICT training
		ICT graduates
Connectivity	Fixed broadband take-up	Overall fixed broadband take-up
		At least 100 Mbps fixed broadband take-up
		At least 1 Gbps take-up
	Fixed broadband coverage	Fast broadband (NGA) coverage
		Fixed Very High-Capacity Network (VHCN) coverage
	Mobile broadband	5G spectrum
		5G coverage
		Mobile broadband take-up
	Broadband prices	Broadband price index
Integration of digital technology	Digital intensity	**SMEs with at least a basic level of digital intensity**
	Digital technologies for businesses	Electronic information sharing
		Social media
		Big data
		Cloud
		AI
		ICT for environmental sustainability
		e-Invoices
	e-Commerce	SMEs selling online
		e-Commerce turnover
		Selling online cross-border
Digital public services	e-Government	e-Government users
		Pre-filled forms
		Digital public services for citizens
		Digital public services for businesses
		Open data

Source: According to DESI 2022

Figure 4 below shows the 2022 DESI ranking of Member States. Finland, Denmark, the Netherlands, and Sweden have the most advanced digital economies in the EU, followed by Ireland, Malta, and Spain. The average result is assessed for Luxembourg, Estonia, Austria, Slovenia, France, Germany, Lithuania, Portugal, Belgium, Latvia, Italy, Czech Republic, Cyprus, Croatia, Hungary, Slovakia, and Poland. Romania, Bulgaria, and Greece have the lowest DESI scores.

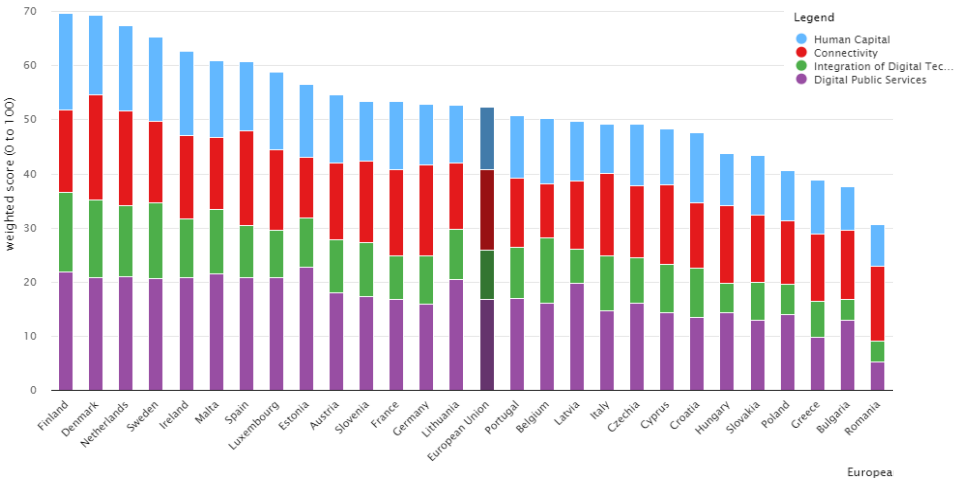

Figure 4: Digital Economy and Society Index (overall, stacked by main dimensions)
Source: https://digital-agenda-data.eu/charts/desi-components

The analysis is focused on 28 countries of the European Union, including the EU, as an average score of EU countries, while the researched development covers 6 periods (from 2017 to 2022). The panel data were used while applying regression models primarily intended for the analysis of such structured data, i.e., the pooled regression model (PRM), the random effects model (REM), and the fixed effects model (FEM). These methods are constructed as follows:

PRM: $DESI_{it} = \alpha + \beta_1 * GDP_{it1} + \beta_2 * UnEmpl_{it1} + \beta_3 * Ex\_Educ_{it1} + \beta_4 * RDE_{it1} + \varepsilon_{it}$ (1)

REM: $DESI_{it} = \beta_1 * GDP_{it1} + \beta_2 * UnEmpl_{it1} + \beta_3 * Ex\_Educ_{it1} + \beta_4 * RDE_{it1} + (\alpha + u_i) + \varepsilon_{it}$ (2)

FEM: $DESI_{it} = \alpha + \beta_1 * GDP_{it1} + \beta_2 * UnEmpl_{it1} + \beta_3 * Ex\_Educ_{it1} + \beta_4 * RDE_{it1} + \varepsilon_{it}$; $\alpha_t = \alpha_{t1} + \alpha_{t2} + \ldots + \alpha_{te}$ (3)

where,
DESI (dependent variable) presents the value of the Digital Economy and Society Index and its dimensions – Human Capital, Connectivity, Integration of digital technology, and Digital public services.

GDP (annual gross domestic product from Eurostat) presents an independent variable. GDP and main components (output, expenditure, and income) are expressed as real expenditure per capita volume indexes in PPP. The authors used real per capita expenditures based on purchasing power parity to account for differences between countries.
UnEmpl expresses the unemployment rate among the active population as a percentage of the active population. The unemployment rate can be taken as a variable whose growth affects the digitization of the country. It can be assumed that these unemployed represent the potential for increased digitization due to possible retraining. However, in this study, we assume a negative impact on digitization. In our opinion, a qualified workforce in the digital field would have no problem getting a job and thus would reduce the unemployment rate.
Ex_Educ presents public expenditure on education by education level and programme orientation and is expressed as % of GDP.
RDE is research and development expenditure by performance sectors. RandD expenditures include all expenditures for RandD performed within the business enterprise sector (BERD) on the national territory during a given period, regardless of the source of funds. RandD expenditure in BERD is shown as a percentage of GDP (RandD intensity). All data are annual and sourced from Eurostat for 2016–2021.
Before each separate regression analysis, we assessed the stationarity of the dependent and independent variables using the Levin, Lin, and Chu test for the presence of unit roots. Before constructing the regression models, we conducted a correlation analysis. To determine the appropriateness of one of the three regression models mentioned above, we used the joint significance test of the averages of separate groups, the Breusch-Pagan test, or the Hausman test statistic. All three methods were only used for the analysis of the complete dataset for the purpose of visualization and comparison.

Research Results

After determining the existence of unit roots by the Levin, Lin, and Chu test (the relevant statistics are given in Table 3), we can confirm the stationarity of the indicators, so it was not necessary to perform any correction (difference) of the indicators. Subsequently, the researchers proceeded to the correlation analysis, the results of which are shown in Table 4.

Table 3. Levin, Lin, and Chu t-test for Stationarity of Data

Variable	Coefficient	t-ratio	z-score	p-value
DESI	-2.0462	-16.7760	-16.0516	0.0000
Human Capital	-0.8923	-6.9210	-6.6608	0.0000
Connectivity	-1.5519	-11.9490	-11.4572	0.0000
Integration of Digital Technology	-1.2291	-10.7450	-10.2687	0.0000
Digital Public Services	-1.6549	-9.9430	-9.5637	0.0000
GDP per capita in PPP	-0.5527	-6.9970	-6.7126	0.0000
Unemployment	-1.0221	-8.7350	-8.3677	0.0000
Research and development expenditure	-1.3186	-13.6920	-13.0722	0.0000

Source: Own elaboration

Table 4. Correlation Analysis

	DESI	DESI_HC	DESI_C	DESI_IDT	DESI_DPS	GDP	Unemp	Ex_educ	RDE
DESI	1.000	**0.831**	**0.760**	**0.890**	**0.927**	**0.489**	**-0.222**	**0.527**	**0.448**
DESI_HC		1.000	**0.378**	**0.797**	**0.758**	**0.550**	-0.101	**0.605**	**0.505**
DESI_C			1.000	**0.563**	**0.590**	**0.247**	**-0.250**	**0.194**	**0.225**
DESI_IDT				1.000	**0.751**	**0.522**	-0.140	**0.621**	**0.546**
DESI_DPS					1.000	**0.415**	**-0.227**	**0.469**	**0.339**
GDP						1.000	-0.133	**0.450**	**0.637**
Unemp							1.000	-0.087	-0.189
Ex_educ								1.000	**0.678**
RDE									1.000

Source: Own elaboration

This analysis confirmed assumptions about a positive correlation between investigated variables and values of the digital economy and society index and its dimensions. The results of the subsequent regression analysis for the independent variable DESI by applying three-panel regression methods are shown in Table 5. Table 7 then shows the regression analysis results for individual DESI dimensions (independent variables) using the most appropriate panel regression method.

Table 5. Comparison of Regression Models for Dependent Variable DESI

	PRM	REM	FEM
constant	9.8838 [0.0343] **	24.2139 [0.0027] ***	−18.7245 [0.2869]
GDP	0.1751 [0.0000] ***	0.0575 [0.4722]	−0.0426 [0.7846]
Unemployment	−0.2860 [0.1446]	−1.2489 [0.0000] ***	−1.5847 [0.0002] ***

Expenditure on education	3.7981 [0.0000] ***	2.9179 [0.0407] **	7.0474 [0.0001] ***
Research and development expenditure	−0.2082 [0.8619]	4.6333 [0.0304] **	25.0442 [0.000] ***
Adjusted R^2	0.3721		0.4962
S.E. of regression	8.3244	9.6552	4.7641
Schwarz criterion	1088.5150	1134.3370	1020.8140
rho	0.9499	0.6837	0.6837
Akaike criterion	1073.4290	1119.2500	927.2780
Hannan-Quinn	1079.5580	1125.3790	965.2771
Durbin-Watson	0.1687	0.4702	0.4702

Source: Own elaboration

To choose between PRM, FEM and REM models, the authors used a test of joint significance of differing group means, Breusch-Pagan test statistic and the Hausman specification test. Based on the results of the individual tests (Table 6), we prefer the model of fixed effects for the independent variable DESI.

Table 6. Panel Test Statistic for Regression Model Selection for Independent Variable DESI

Panel test	F/LM/H	p-value
Test of joint significance of differing group means	12.5287	0.0000
Breuch-Pagan test statistics	64.4950	0.0000
Hausman test statistics	70.7160	0.0000

Source: Own elaboration

Table 7. Regression Models for Dependent Variables DESI – Human Capital, Connectivity, Integration of Digital Technology and Digital Public Services

	Human Capital	Connectivity	Integration of Digital Technology	Digital Public Services
model	FEM	FEM	FEM	FEM
constant	6.4873 [0.0000] ***	−19.9076 [0.0180] **	−1.1563 [0.7725]	−4.1479 [0.3989]
GDP	−0.0007 [0.9586]	−0.0153 [0.8359]	−0.0383 [0.2830]	0.0116 [0.7902]
Unemployment	−0.1263 [0.0003] ***	−0.6526 [0.0013] ***	−0.2811 [0.0037] ***	−0.5247 [0.0000] ***
Expenditure on education	0.5438 [0.0003] ***	3.7932 [0.0000] ***	1.001 [0.0147] **	1.7098 [0.0008] ***
Research and development expenditure	1.8257 [0.0000] ***	10.2206 [0.0000] ***	5.4869 [0.000] ***	7.5110 [0.000] ***
R^2	0.9770	0.6051	0.8626	0.9118
Adjusted R^2	0.4548	0.4419	0.4243	0.5444

S.E. of regression	0.3919	2.2582	1.0860	1.3335
Schwarz criterion	266.5326	795.3549	574.2845	636.2799
rho	0.4722	0.6457	0.6772	0.6506
Akaike criterion	172.9969	701.8192	480.7488	542.7443
Hannan-Quinn	210.9960	739.8182	518.7479	580.7433
Durbin-Watson	0.7111	0.6271	0.4076	0.4331

Source: Own elaboration

Based on the above results, we conclude that most of the considered coefficients are statistically significant, except for expenditure per capita in PPP. The non-confirmation of the impact of GDP on DESI is the opposite of the result of the study by the authors Stavytskyy, Kharlamova, and Stoica (2019). According to their research, the state development level positively impacts the structural parts of DESI. Since the economic growth of a country is normally measured by national output in terms of GDP, it is possible that the effects of digitization cannot easily be identifiable at the macro level (Marino et al., 2022).

Tables 8 and 9 show the resulting values of statistically significant coefficients after omitting GDP per capita in PPP from the considered models.

Table 8. Regression Model For Dependent Variables DESI without GDP

	Coefficient	Std. Error	t-ratio	p-value
Constant	−22.3548	11.3888	−1.963	0.0520 *
Unemployment	−1.57119	0.412102	−3.813	0.0002 ***
Expenditure on education	6.98450	1.75182	3.987	0.0001 ***
Research and development expenditure	24.9240	3.97454	6.271	0.0000 ***
Adjusted R^2	0.4958	R^2		0.8353
S.E. of regression	4.7458	Akaike criterion		925.3724
Schwarz criterion	1015.8910	Hannan-Quinn		962.1457
rho	0.6863	Durbin-Watson		0.4662

Source: Own elaboration

Table 9. Regression Model for Dependent Variables DESI Dimensions – Human Capital, Connectivity, Integration of Digital Technology and Digital Public Services without GDP

	Human Capital	Connectivity	Integration of Digital Technology	Digital Public Services
model	REM	FEM	FEM	FEM
constant	7.3243	−21.2121	−4.4146	−3.1586

	[0.0000] ***	[0.0001] ***	[0.0931] *	[0.3237]
Unemployment	−0.1263 [0.0000] ***	−0.6478 [0.0012] ***	−0.2689 [0.0051] ***	−0.5283 [0.0000] ***
Expenditure on education	0.4982 [0.0003] ***	3.7706 [0.0000] ***	0.9442 [0.0202] **	1.7269 [0.0006] ***
Research and development expenditure	1.5424 [0.0000] ***	10.1774 [0.0000] ***	5.3789 [0.000] ***	7.5437 [0.000] ***
R^2	0.9770	0.6052	0.8633	0.9118
Adjusted R^2	0.4548	0.4420	0.4388	0.5442
S.E. of regression	1.9704	2.2492	1.0867	1.3283
Schwarz criterion	650.3952	790.3918	570.7234	631.3521
rho	0.4727	0.6480	0.6891	0.6492
Akaike criterion	638.3261	699.8734	480.2050	540.8337
Hannan-Quinn	643.2292	736.6467	516.9783	577.6070
Durbin-Watson	0.7102	0.6242	0.3915	0.4359

Source: Own elaboartion

The results show that the unemployment rate reduces the values of the DESI index and its dimensions. In other words, the increase in unemployment hinders the digital development of the economy and society.

The above values show that the percentage growth of public expenditure on education and expenditure on research and development significantly impacts DESI and its dimensions. The most significant changes are in the case of research and development expenditure. It is understandable because research and experimental development comprise creative work undertaken systematically to increase knowledge, including knowledge of man, culture, and society, and using this knowledge to devise new applications. The obtained models are statistically significant; thus, the established hypotheses can be confirmed. These findings and indicators can be an added value to managing the digital development of countries.

Discussion

With their clearly defined objectives, EU digital transformation strategies are necessary for modern strategic, financial, innovation, and information management. Their implementation strengthens the ability of organizations to adapt to dynamic changes in the global economy and, at the same time, helps them use digital technologies at different levels of management. In this context, it is important to constantly look for new drivers such as human capital, an educated workforce, productivity, investment, innovation, technology and digital transformation. These factors influence strategic management and decision-making, shaping the direction of further development of the company.

The virtual nature of today's business, where company management, processes and employees are moving to an online environment, emphasizes the importance of digitally highly skilled human capital, Internet connectivity and availability, and the integration of digital technologies within the company. Digitization of public services is also helpful to simplify business. DESI, with its dimensions, represents key indicators for policymakers and managers to successfully manage their business activities. The results of our study and the importance of digitization in the field of management are supported by several researchers (Pekarčíková et al., 2021; Başol, Yalçın, 2021; Moroz, 2017).

A strong digital economy is vital for innovation, growth, jobs, and European competitiveness. Today, many companies struggle with the lack of sufficiently qualified labor in the domestic labor markets and are turning abroad. It is essential to take measures so that even the long-term unemployed can rejoin working life and thus offer new and existing companies a high-quality and qualified workforce in sufficient quantity (Korečko, Vravec, 2023). Therefore, the spread of digital literacy has a massive impact on the labor market and the skills needed in the economy and society (Stofkova et al., 2022). Nagy and Somosi (2022) conclude that the digital transformation of the economy and society significantly impacts the capacity for social innovation. Skare, de Obesso and Ribeiro-Navarrete (2023) investigated the impact of digital technologies (through the DESI index) on the business activities of SMEs. They found out that digital transformation strengthens SMEs' ability and flexibility to address main business issues. However, digital transformation also brings risks, such as the shortage of skilled labor and experienced managers and loss of inherent competitiveness. Başol and Yalçın (2021) focused on determining the effects of DESI on labor market indicators (labor market uncertainty, long-term unemployment rate, employment rate, and personal earnings). Their study concluded that an increase in DESI increased employment rates and personal earnings and reduced long-term unemployment and labor market insecurity. Our analysis confirmed that a higher level of unemployment leads to a decrease in the digital development of the economy and society (DESI value). Toader et al. (2018) studied the relationship between using ICT infrastructure and economic growth in the European Union (EU) countries. In this study, the impact of the level of economic development (GDP) on the country's digitisation level has not been confirmed.

Assessing the digital development of Romanian enterprises, Martin et al. (2013) underlined the role of human capital as one of the major factors influencing enterprise digitization.

Conclusion

The digital economy become a new engine of economic growth and plays a key role in society and the economy. The findings should interest scholars, policymakers, businesses, and managers (Chen, Wu, 2022). The DESI 2022 results show that while most Member States are making progress in their digital transformation, businesses' adoption of key digital technologies remains low among the EU frontrunners. Insufficient levels of digital skills hamper future growth prospects, deepen the digital divide, and increase the risks of digital exclusion (European Commission, 2022).
The present study assessed four hypotheses. The impact of the level of economic development (GDP) on the level of digitization of the country has not been confirmed. The analysis confirmed that a higher level of unemployment leads to a decrease in the digital development of the economy and society (DESI value). The third hypothesis evaluated the impact of education expenditure on DESI. The study showed that it is possible to increase the DESI level by spending more resources on education. An increase in education expenditure can be reflected not only in the better development of human capital in the field of digitization (through education itself) but also in the increase of Connectivity, Integration of Digital Technology, and Digital Public Services. The growing demands of society require their introduction and improvement. The last (fourth) hypothesis explored if higher research and development expenditure increases the level of digital development of the economy and society. Research has shown that this variable has the most significant impact on the change in DESI. This is a disadvantage for Slovakia, which belongs to the countries with the lowest expenditures on research and development. This may also be one of the reasons for the relatively low level of DESI. Slovakia also lags in areas and key factors for innovation, such as the quality of digital public administration, education (human resources and digital skills), research, technological readiness, and digital innovation.
The challenges for improving the digital economy and competitiveness are focusing on the financial support of socioeconomic indicators in areas of human capital in digital education at all levels, using digital skills for the digital labour market and the workforce, creation of digital infrastructure in different areas of the economy, stimulation of investment in digital technologies projects and digital innovation in R and D for e-business and e-society.
Despite the limit that every study can inevitably have, this study highlights the importance of exploring drivers of the digital economy and points out the economic and social connections of improving digitalization as strategic managerial implications for policies. The limitation of the research object to EU countries only (because of the analysed index) can be considered a limitation of the study. Limitations of the research were also shorter time data of the observed variables,

imprecise agreement in the definitions of data from individual countries, or the availability of the data themselves. Implications for future research could, therefore, be to improve the data and expand the study sample. In addition, it would be advisable to add control variables to see if they are appropriate and assess their true effect on the explained variables as much as possible.

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References

Androniceanu, A., Georgescu, I., (2023). Digital competences and human development: a canonical correlation analysis in Romania. *Polish Journal of Management Studies*, *28*(1), 43-61.

Başol, O., Yalçın, E. C., (2021). How does the digital economy and society index (DESI) affect labor market indicators in EU countries? *Human Systems Management*, *40*(4), 503-512.

Chen, W., Wu, Y., (2022). Does intellectual property protection stimulate digital economy development? *Journal of Applied Economics*, *25*(1), 723-730.

European Commission., (2022). The Digital Economy and Society Index (DESI) 2022. https://digital-strategy.ec.europa.eu/sk/node/11127

Feng, Z., Wang, H. and Wei, L., (2019). Research and Prospect of Digital Economy Development in Shandong Province. In X. Du, C. Huang, and Y. Zhong (Eds.), *Proceedings of the 2019 5th International Conference on Humanities and Social Science Research (ICHSSR 2019)* (pp. 555-558). Atlantis Press.

Imran, M., Liu, X., Wang, R., Saud, S., Zhao, Y. and Khan, M. J., (2022). The Influence of Digital Economy and Society Index on Sustainable Development Indicators: The Case of European Union. *Sustainability*, *14*(18), Article e11130.

Ionescu, A. M., Clipa, A. M., Turnea, E. S., Clipa, C. I., Bedrule-Grigoruță, M. V. and Roth, S., (2022). The impact of innovation framework conditions on corporate digital technology integration: Institutions as facilitators for sustainable digital transformation. *Journal of Business Economics and Management*, *23*(5), 1037-1059.

Jurčević M., Lulić L. and Mostarac V., (2020). The Digital Transformation of Croatian Economy Compared with EU Member Countries. *Ekonomski Vjesnik: Osijek*, *33*(1), 151-164.

Karpunina, E. K., Konovalova, M. E., Ermolaev, K. N., Okunkova, E. A. and Yakovleva, E. A. (2019). The social dimension of the digital economy. In KS. Soliman (Eds.), *Vision 2025: Education Excellence and Management of Innovations through Sustainable Economic Competitive Advantage* (pp. 3688-3696). INT IBIMA.

Korečko, J., Vravec, J., (2023). Nezamestnanosť ako významný faktor stabilnej udržateľnosti existencie podnikov na Slovensku av EÚ. *Journal of global science*, *8*, 1-9.

Laitsou, E., Kargas, A. and Varoutas, D., (2020). Digital competitiveness in the European Union era: The Greek case. *Economies*, *8*(4), 85.

Le Thanh, H., (2022). Accelerating digital transformation implementation in the fight against corruption? Evidence from European countries before and during the COVID-19 pandemic. *International Journal of Electronic Government Research (IJEGR)*, *18*(2), 1-27.

Liu, T. C., (2022). Digital policy in European countries from the perspective of the Digital Economy and Society Index. *Policy and Internet*, *14*(1), 202-218.

Marino, A., Pariso, P., (2022). Digital economy: Technological, organizational and cultural contexts for the development of cooperation in Europe. *Entrepreneurship and Sustainability Issues*, *9*(2), 363-383.

Martin, F. M., Ciovica, L. and Cristescu, M. P., (2013). Implication of Human Capital in the Development of SMEs through the ICT Adoption. *Procedia Economics and Finance*, *6*, 748-753.

Moroz, M., (2017). The level of development of the digital economy in Poland and selected European countries: a comparative analysis. *Foundations of Management*, *9*(1), 175-190.

Nagy, S., Somosi, M. V., (2022). The relationship between social innovation and digital economy and society. *Regional Statistics*, *12*(2), 3-29.

Otola, I., Knop, L., (2023). A bibliometric analysis of resilience and business model using VOSviewer. *Polish Journal of Management Studies*, *28*(2), 255-273.

Pekarčíková, M., Ižaríková, G., Trebuňa, P. and Kliment, M., (2021). Digitalisation importance and influence on the competitiveness of industrial enterprises in the time of the Covid-19 pandemic. *Polish Journal of Management Studies*, *24*(2), 370-385.

Pînzaru, F., Dima, A. M., Zbuchea, A. and Vereș, Z., (2022). Adopting sustainability and digital transformation in business in Romania: A multifaceted approach in the context of the just transition. *Amfiteatru Economic*, *24*(59), 27-44.

Rakićević, J., Rakićević, A. and Poledica, A., (2019). Logical clustering approach for analysing digital economy and society performance of countries. In V. Novak, V. Marik, M. Stepnicka, M. Navara, and P. Hurtik (Eds.), *Proceedings of the 11th Conference of the European Society for Fuzzy Logic and Technology (EUSFLAT 2019)* (pp. 550-557). Atlantis Press.

Ren, S., Li, L., Han, Y., Hao, Y. and Wu, H., (2022). The emerging driving force of inclusive green growth: does digital economy agglomeration work? *Business Strategy and the Environment*, *31*(4), 1656-1678.

Skvarciany, V., Lapinskaite, I. and Stasytyte, V., (2023). Efficiency of Digital Economy in the Context of Sustainable Development: DEA-Tobit Approach. *Prague Economic Papers*, *32*(2), 129-158.

Skare, M., de Obesso, M. D. L. M. and Ribeiro-Navarrete, S., (2023). Digital transformation and European small and medium enterprises (SMEs): A comparative study using digital economy and society index data. *International Journal of Information Management*, *68*, Article e102594.

Stavytskyy, A., Kharlamova, G. and Stoica, E. A., (2019). The analysis of the digital economy and society index in the EU. *TalTech Journal of European Studies*, *9*(3), 245-261.

Stofkova, J., Poliakova, A., Stofkova, K. R., Malega, P., Krejnus, M., Binasova, V. and Daneshjo, N., (2022). Digital skills as a significant factor of human resources development. *Sustainability*, *14*(20), Article e13117.

Štefko, R., Vašaničová, P., Jenčová, S. and Pachura, A., (2021). Management and economic sustainability of the Slovak industrial companies with medium energy intensity. *Energies*, *14*(2), Article e267.

Tao, J., Wang, Z. and Li, J., (2023). The spatial effect of digital economy on public psychological resilience during the diffusive crisis. *Frontiers in Public Health*, *11*, Article e1156367.

Tiutiunyk, I. V., Zolkover, A., Maslov, V., Vynnychenko, N. V., Beshley, Y. and Kovalenko, O., (2020). Indices of innovation activity as components of macroeconomic stability assessment: how does the shadowing of investment flows affect? *Marketing and Management of Innovations*, *4*, 26-40.

Toader, E., Firtescu, B. N., Roman, A. and Anton, S. G., (2018). Impact of information and communication technology infrastructure on economic growth: An empirical assessment for the EU countries. *Sustainability*, *10*(10), Article e3750.

Vasyltsiv, T., Mulska, O., Levytska, O., Lupak, R., Semak, B. and Shtets, T., (2022). Factors of the Development of Ukraine's Digital Economy: Identification and Evaluation. *Science and Innovation*, *18*(2), 44–58.

Volkova, N., Kuzmuk, I., Oliinyk, N., Klymenko, I., and Dankanych, A. (2021). Development trends of the digital economy: E-business, e-commerce. *International Journal of Computer Science and Network*, *21*(4), 186-198.

Yilmaz, Y. (2021). Transition to the Digital Economy, Its Measurement and the Relationship between Digitalization and Productivity. *Istanbul Journal of Economics= İstanbul İktisat Dergisi*, *71*(1), 283-316.

CZYNNIKI NAPĘDOWE GOSPODARKI CYFROWEJ – JAK KRAJE MOGĄ ZARZĄDZAĆ SWOIM ROZWOJEM CYFROWYM

Streszczenie: Gospodarka cyfrowa i technologie odgrywają kluczową rolę w zwiększaniu konkurencyjności krajów. Niniejsze badanie ma na celu zbadanie wpływu wybranych wskaźników społeczno-ekonomicznych na Indeks Gospodarki i Społeczeństwa Cyfrowego (DESI) i jego wymiary w celu znalezienia czynników napędowych gospodarki cyfrowej. W przeglądzie literatury wykorzystano podejście oparte na metaanalizie bibliometrycznej jako narzędziu wizualizacji. Do analizy wykorzystano modelowanie regresji danych panelowych. Badanie to zidentyfikowało wskaźniki społeczno-ekonomiczne, które mogą poprawić pozycję kraju w DESI. Najbardziej znaczące zmiany dotyczą wydatków na badania i rozwój. Wyniki wskazują na ekonomiczne i społeczne powiązania pomiędzy udoskonaleniem cyfryzacji a strategicznymi implikacjami zarządczymi dla polityki. Nowością tego badania jest wskazanie wskaźników ekonomicznych, które wpływają na poprawę indeksu DESI i pozytywnie oddziałują na przyszły rozwój gospodarki cyfrowej kraju.

Słowa kluczowe: DESI, cyfrowo wykwalifikowana siła robocza, wskaźniki społeczno-ekonomiczne, wydatki na badania i rozwój, kapitał ludzki