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Methodological Development of Digital Economy Indices: A Review and Agenda for Future Research

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Methodological Development of Digital Economy Indices: A Review and Agenda for Future Research

Abstract:

This article aims to expand our understanding of the methodological development of digital economy indices and determine the importance of their application in scientific research. As research methodology, a systematic literature review is applied. Scholars' increased interest in this topic has been particularly pronounced in the last few years (after 2017). Research on digital economy indices is regularly conducted and is constantly enhancing with the constructions and implementations of new methodological approaches. Identified shortcomings and advantages of a particular index of the digital economy not only facilitate the selection and employment of appropriate indices in upcoming research, but also enable a high-quality analysis of the results obtained. Besides the analysed shortcomings and advantages, the chronological overview of the development of digital economy indices contributes to their methodological improvements in upcoming research. In addition to insight into existing results, the review of empirical findings reveals insufficiently researched topics. Finally, the outcomes demonstrated in this study might be a sound basis and motivation for achieving new contributions in future scientific papers.

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Keywords: digital economy indices, methodological development, research agenda

JEL classification: 033

1. Introduction

Using digital computing technologies, the digital economy finds its application in numerous economic sectors. Online business interactions contribute to market transparency and efficiency and ultimately enable easier access to products (Xia et al., 2023). The application of digital technologies in economic life gained additional importance due to the coronavirus pandemic (Zhang et al., 2022). The growing importance of digital technologies in everyday business activities has created the need for efficient monitoring of the effects and outcomes of the digitization process on economic activity. In these circumstances, the development of analytical tools for researching the contribution of digital technologies to economic activity arouses an increasing interest of researchers (Wang & Shi, 2021; Stanković et al., 2021; Luo & Zhou, 2022; Li et al., 2022). Along with the development of the methodological framework, there is a continuous need to establish and upgrade internationally comparable statistical data (Ferracane & van der Marel, 2020; Cahyadi & Magda, 2021; Skare et al., 2023).

This study aims to determine, explore, and critically evaluate methodological and empirical research on digital economy indices. The following research questions are addressed: What are the most cited papers on digital economy indices? What are the most cited journals in which papers on the topic have been published? What are the most important digital economy indices applied in recent research? How was the methodology based on the construction, upgrading, and application of digital economy indices chronologically improved? What are the most relevant findings from the application of digital economy indices in empirical research? What are potential future research directions for improving the measurement framework based on digital economy indices?

The research was conducted by applying a systematic literature review methodology (Tranfield et al., 2003; Prasad et al., 2018; Grilli et al., 2019; Snyder, 2019; Anton & Nucu, 2020; Buturac, 2022). The research period was from 2000 to 2022.

A systematic overview of the empirical literature on digital economy indices has not previously been conducted. This study provides important contributions to the scientific literature. First, it gives a complete picture of the published studies on digital economy indices and includes a comprehensive citation-based content analysis covering the methodological development, empirical findings, and research agenda. Second, the study brings together information on the relevant sources of published papers on digital economy indices as well as guidelines for researchers interested in applying a systematic literature review as a research method. Third, an overview of the limits and advantages of digital economy indices not only facilitates the selection and application of the appropriate index in future analytical works, but also contributes to a better interpretation of the results obtained. Finally, this contribution to the literature is motivated by the importance of further methodological development of digital economy indices in scientific research. Measuring the digital economy is not only of an economic nature, but also has statistical and mathematical implications. Therefore, the results presented here are a good basis for further research across a range of research areas.

A discussion of the methodology follows this introductory section. A citation-based analysis is conducted in Section 3. Section 4 is devoted to content analysis and includes an overview of digital economy indices, methodology development, empirical findings, and research agenda. Section 5 concludes.

2. Methodology

As research methodology, a systematic literature review is used (Tranfield et al., 2003; Prasad et al., 2018; Buturac, 2022). A more detailed explanation of the applied methodological framework, including phases, aims, and guideline questions, is presented in Table 1. In this article, the analysed research sample comprises the literature on digital economy indices published between 2000 and 2022, indexed in the ISI Web of Science database.

Table 1. Systematic Literature Review – Phases and Guideline Questions

Phase	Aim/s	Guideline questions
Phase 1: *Designing the review*	Research questions identified. Overall review approach considered. Research strategy established.	• Is the literature review on digital economy indices needed? • What is the scientific contribution of the research? • What is the research scope? • What are key research questions? • What is the research strategy?
Phase 2: *Conducting the review*	Papers selected, classified, and explained.	• Is the research strategy relevant to provide a representative sample of papers on digital economy indices? • How are the criteria applied for the selection of scientific papers explained? • How is the robustness of the research methodology appraised?
Phase 3: *Analysis*	Content analysis of selected research papers performed.	• Is the research method relevant for the content analysis? • Are the data abstracted in the form of descriptive information, such as authors, years published, topic, or type of study, or in the form of effects and findings? • How are the selected research papers categorised under different themes?
Phase 4: *Writing the review*	Literature review reported and structured.	• Is the process of designing the review described transparently? • Is the literature identified, analysed, synthesised, and presented in a scientifically justified and consistent way? • Are the contributions to the academic literature realised and clearly presented?

Source: Author's systematization following Anton and Nucu (2020), Snyder (2019), Prasad et al. (2018), and Buturac (2022).

The initial studies collected according to the research aim must be sorted at the beginning of the research process. For this purpose, it is necessary to define the criteria for including articles in the research sample. The inclusion criteria for the systematic literature review in this study address the following key aspects: methodological development, geographical dimension, sectoral dimension, and empirical findings (Table 2).

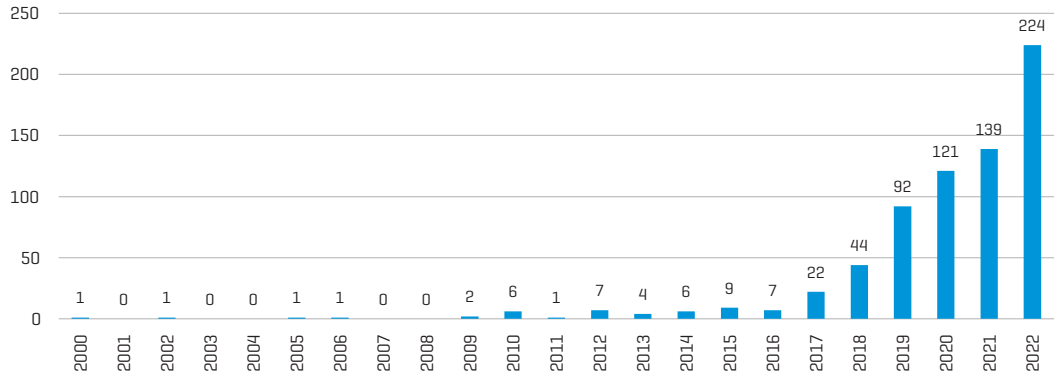
Table 2. Inclusion Criteria for the Systematic Literature Review

Inclusion criteria	Description
Methodological development	Comprise all studies that contribute to methodological development on the research topic.
Geographical dimension	Comprise all studies that provide new evidence on methodological development and application of digital economy indices in specific geographical regions or countries.
Sectoral dimension	Comprise all studies that contribute to methodological development of digital economy indices for a specific sector, such as public administration, rural sector, or finance.
Empirical findings	Comprise all studies that contribute to the application of empirical research of digital economy indices analysed.

Source: Author's systematization.

The number of publications per year on digital economy indices in the 2000–2022 period is presented in Figure 1. The search for papers took place in March 2023. Until 2016, with few oscillations, a relatively small number of articles was published. But, from 2016 to 2022, the number of published articles experienced a rapid expansion.

Figure 1. Results of ISI Web of Science Search for 'Digital Economy Indices' in the Title of Publications for the Period 2000–2022 (Number of Publications)



Source: Web of Science database.

Other studies propose beginning the review process by searching for studies on digital economy indices (Huang et al., 2016; Anton & Nucu, 2020; Abideen et al., 2021). For this purpose, I used the ISI Web of Science, an international bibliographic database that contains highly rated journals. Article collection was based on a keyword search for the phrase 'digital economy indices'. The preliminary search yielded an initial pool of 688 unique contributions, including peer-reviewed articles, conference proceedings, review articles, book chapters, editorial materials, and early access articles. An overview of the initial search results by document type is set out in Table 3.

Table 3. Breakdown by Document Type of Initial Contributions to the Literature on Digital Economy Indices for the Period 2000–2022

Document type	Number of research works	% of the total
Article	526	76.5
Proceeding paper	108	15.7
Review article	9	1.3
Book chapter	20	2.9
Editorial material	3	0.4
Early access	20	2.9
Data paper	1	0.1
Retraction	1	0.1
Total	688	100.0

Source: ISI Web of Science database.

After collection, the articles were sorted in line with the paper's aim and defined methodological framework. Certain document types were eliminated in the selection process, including editorial materials and early access articles. In the next step, articles not in line with the key research questions were excluded. After collecting, sorting, and selecting the articles, the final sample comprised 170 impactful studies.

3. Citation-Based Analysis

At the very beginning of the citation-based analysis, the following research question is addressed: 'What are the journals that have published the greatest number of articles from said research?' The top 10 Web of Science publications, according to the number of papers published on digital economy indices, are as follows: *Sustainability*, *Advances in Economics*, *Business and Management Research*, *International Journal of Environmental Research and Public Health*, *Environmental Science and Pollution Research*, *Technological Forecasting and Social Change*, *Advances in Intelligent Systems and Computing*, *Computational Intelligence and Neuroscience*, *Plos One*, *Technology in Society*, and *Ekonomika Regiona – Economy of Regions*. Table 4 sets out the publications that have published more than five papers on the topic in descending order by the number of articles published, together with an average number of citations, over the 2000–2022 period. Apart from the 25 journals listed in Table 4, nine journals have published four articles on digital economy indices, 24 journals have published three articles, 55 journals have published two articles, and 82 journals have published only one article. These journals are not included to preserve space.

The results presented in Table 4 reveal a high degree of dispersion across publications of articles on the topic. Although the number of papers published on digital economy indices is relatively high, the number of papers per journal is relatively low. Similar findings are confirmed in other research fields, such as working capital management (Prasad et al., 2018), enterprise risk management (Anton & Nucu, 2020), and measures of economic forecast accuracy (Buturac, 2022). An analysis of the average number of citations per year from the Web of Science Core Collection shows that the journal *Sustainability* has the highest citations per article (58), followed by *Environmental Science and Pollution Research* (46.67).

It seems particularly interesting to analyse the most cited articles in this research area. Table 5 presents the top 20 studies on digital economy indices in descending order of citation. In addition to the titles of the articles and the number of citations, Table 5 lists the authors' names, the year of publication, and the journal in which each article is published. The results presented in the table show that in the Web of Science Core Collection, the *Journal of Information Technology* has the highest citations per paper in the 2000–2022 period (115 citations) for the study 'Measuring the digital divide: A framework for the analysis of cross-country differences' (Corrocher & Ordanini, 2002). Constructing a synthetic index of digitalization, this study proposes a new model for measuring the digital divide within a set of countries or geographical areas.

The highest average number of citations per year is attributed to the *Journal of Business Research* (29 citations) for the article 'Digital economy: An innovation driver for total factor productivity' (Pan et al., 2022). Examining the innovation-driven effects of the digital economy on total factor productivity (TFP) in China, Pan et al. (2022) propose a new digital economy index. Analysis results confirm the hypothesis that the proposed digital economy index has a positively nonlinear relationship with total factor productivity (TFP).

Section 4 – Content Analysis – sets out the contributions of other related papers to an overview of digital economy indices, methodology development, and empirical application.

Table 4. Top 25 Source Titles (by Record Count)

No.	Title of the journal	Number of articles	Average number of citations per year from the Web of Science Core Collection
1	Sustainability	38	58
2	Advances in Economics, Business and Management Research	13	1.5
3	International Journal of Environmental Research and Public Health	13	21.75
4	Environmental Science and Pollution Research	10	46.67
5	Technological Forecasting and Social Change	9	14.75
6	Advances in Intelligent Systems and Computing	8	4.67
7	Computational Intelligence and Neuroscience	8	2.5
8	Plos One	8	12.33
9	Technology in Society	8	41.33
10	Ekonomika Regiona – Economy of Regions	7	6.2
11	Entrepreneurship and Sustainability Issues	6	10.67
12	European Proceedings of Social and Behavioural Sciences	6	0.67
13	Financial and Credit Activity: Problems of Theory and Practice	6	2.67
14	Journal of Cleaner Production	6	19.29
15	Mathematical Problems in Engineering	6	1.33
16	Proceedings of the International Conference on Business Excellence	6	2.5
17	Advances in Social Science, Education and Humanities Research	5	0
18	Economic Annals-XXI	5	3.2
19	Estudios de Economía Aplicada	5	3.67
20	Frontiers in Environmental Science	5	23.5
21	Lecture Notes in Networks and Systems	5	1.75
22	Mobile Information Systems	5	0
23	Studies in Systems, Decision and Control	5	0
24	Sustainable Development of Modern Digital Economy	5	0.67
25	Telecommunications Policy	5	4.13

Source: Web of Science database.

Table 5. Top 20 Studies on Digital Economy Indices in Descending Order of Their Citations

No.	Title of the paper	Author(s)	Number of citations	Average number of citations per year	Year of publication	Journal
1	Measuring the digital divide: A framework for the analysis of cross-country differences	Corrocher, N.; Ordanini, A.	115	5.23	2002	Journal of Information Technology
2	Digital economy: An innovation driver for total factor productivity	Pan, W. R.; Xie, T.; Wang, Z. W.; Ma, L. S.	87	29	2022	Journal of Business Research
3	Digitalization in economy and innovation: The effect on social and economic processes	Afonasova, M. A.; Panfilova, E. E.; Galichkina, M. A.; Slusarczyk, B.	70	14	2019	Polish Journal of Management Studies
4	Digital economy development, industrial structure upgrading and green total factor productivity: Empirical evidence from China's cities	Liu, Y.; Yang, Y. L.; Li, H. H.; Zhong, K. Y.	62	27.5	2022	International Journal of Environmental Research and Public Health
5	Impact of ICT development on economic growth: A study of OECD European Union countries	Fernandez-Portillo, A.; Almodovar-Gonzalez, M.; Hernandez-Mogollon, R.	56	14	2020	Technology in Society
6	How should we understand the digital economy in Asia? Critical assessment and research agenda	Li, K.; Kim, D. J.; Lang, K. R.; Kauffman, R. J.; Naldi, M.	53	13.25	2020	Electronic Commerce Research and Applications
7	E-government development and the digital economy: A reciprocal relationship	Zhao, F.; Wallis, J.; Singh, M.	49	5.44	2015	Internet Research
8	Digital economy, technological innovation, and green economic efficiency – Empirical evidence from 277 cities in China	Li, J. L.; Chen, L. T.; Chen, Y.; He, J. W.	49	16.33	2022	Managerial and Decision Economics
9	Digitalization of the EU economies and people at risk of poverty or social exclusion	Kwilinski, A.; Vyshnevskyi, O.; Dzwigol, H.	48	12	2020	Journal of Risk and Financial Management
10	Pattern of technological innovations in small enterprises: A comparative perspective of Bangalore (India) and Northeast England (UK)	Subrahmanya, M. H. B.	47	2.47	2005	Technovation
11	The role of e-governance in combating COVID-19 and promoting sustainable development: A comparative study of China and Pakistan	Ullah, A.; Pinglu, C.; Ullah, S.; Abbas, H. S. M.; Khan, S.	46	11.5	2020	Chinese Political Science Review
12	The impact of digital technology usage on economic growth in Africa	Solomon, E. M.; van Klyton, A.	42	10.5	2020	Utilities Policy

Table 5. Cont.

13	A usability assessment of e-government websites in Sub-Saharan Africa	Verkijika, S. F.; De Wet, L.	40	6.67	2018	International Journal of Information Management
14	Does digital finance promote manufacturing servitization: Micro evidence from China	Chen, S. Q.; Zhang, H.	37	12.33	2021	International Review of Economics & Finance
15	Digitalization and society's sustainable development – Measures and implications	Jovanovic, M.; Dlacic, J.; Okanovic, M.	30	5	2018	Zbornik radova Ekonomskog fakulteta u Rijeci – Proceedings of Rijeka Faculty of Economics
16	The analysis of the Digital Economy and Society Index in the EU	Stavytskyy, A.; Kharlamova, G.; Stoica, E. A.	29	5.8	2019	Baltic Journal of European Studies
17	An alternative measure of the ICT-Opportunity Index	Emrouznejad, A.; Cabanda, E.; Gholami, R.	27	1.93	2010	Information & Management
18	The level of development of the digital economy in Poland and selected European countries: A comparative analysis	Moroz, M.	25	3.57	2017	Foundations of Management
19	Digital financial inclusion and sustainable growth of small and micro enterprises – Evidence based on China's New Third Board Market listed companies	Yang, L.; Zhang, Y.	21	5.25	2020	Sustainability
20	What the overall Digital Economy and Society Index reveals: A statistical analysis of the DESI EU28 dimensions	Banhidi, Z.; Dobos, I.; Nemeslaki, A.	17	4.25	2020	Regional Statistics

Source: Web of Science database.

4. Content Analysis

The content analysis is divided into four main sections: an overview of digital economy indices, a review of methodology development, an overview of empirical findings, and a research agenda. The chapter begins with an overview of digital economy indices, including a description of the main features of each index.

4.1. An Overview of Digital Economy Indices

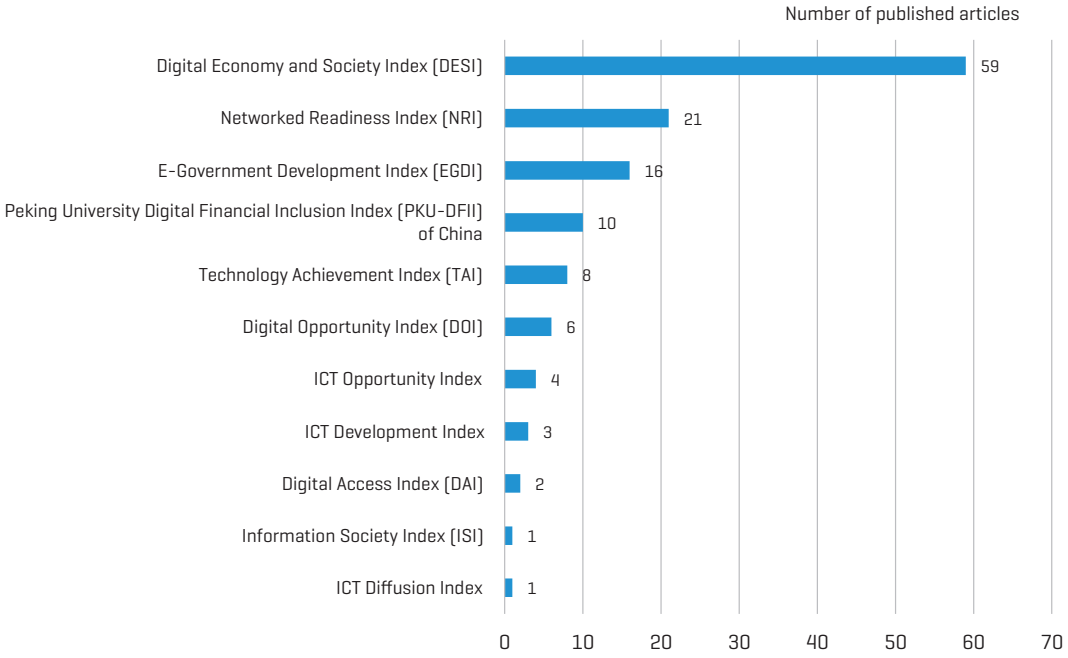
Digitalization leads to significant changes not only in people's everyday lives but also in all spheres of economic life. The direction and dynamics of these changes certainly differ between individual countries. All these changes require an appropriate analytical framework for conducting scientifically justified and consistent research. This includes an analysis of the dynamics of the progress of the digital economy in individual countries, the causes and consequences of the emergence of various trends, and the effects of the digital economy on the development of individual economic sectors. In developing the methodological framework, digital economy indices certainly play an unavoidable role. In the last 20 years, various institutions have contributed to the creation and development of digital economy indices, such as the United Nations (UN), World Economic Forum (WEF), International Telecommunication Union (ITU), and Economist Intelligence Unit (EIU). Among all these institutions, the International Telecommunication Union (ITU) stands out from the rest. Namely, this institution alone has created four digital economy indices: the Digital Access Index (2003), the Digital Opportunity Index (2005), the ICT Opportunity Index (2009), and the ICT Development Index (2009). Considering the sample size of countries included in the application of the index and its wide usage in scientific and professional research, the NRI index, developed in 2002 by the World Economic Forum (WEF), plays a very important role. Among the scientific community, a special place in the development of digital economy indices is occupied by the Institute of Digital Finance at Peking University, which designed the Digital Financial Inclusion Index (PKU-DFII). To monitor the digital development of the European Union countries, the European Commission created the DESI index in 2014 (European Commission, 2022).

Desai et al. (2002) recognized the necessity of designing an index that calculates a country's skills with respect to the latest technologies, such as work skills, innovation skills, etc. Thus, in 2002, the Technology Achievement Index (TAI) was constructed and developed. The digitization of public services is extremely important for successful economic development, as well as overall social development. Therefore, in 2002, the United Nations developed the E-Government Development Index (EGDI). The EGDI index assesses the government's online presence in terms of service delivery, telecommunication infrastructure, and human resource endowment. It is calculated for the 193 member states of the UN. EGDI can serve as a benchmarking tool for countries to identify their strengths and weaknesses and shape their e-government policies. In addition to various institutions, numerous researchers have recently made a significant contribution to the methodological development of digital economy indices (Wong et al., 2009; Gaaloul & Khalfallah, 2014; Ojanperae et al., 2019; Ferracane & van der Marel, 2020; Popov & Semyachkov, 2020; Goh, 2021; Li et al., 2021; Corrocher & Ordanini, 2002; Bai et al., 2022; Luo & Zhou, 2022; Wang et al., 2022; Chen & Wu, 2022; Toh Hao

et al., 2022). This will be discussed in more detail in section 4.2. A detailed overview of digital economy indices, including the publisher, year of first publication, number of countries for which the index is calculated, a short description of each index, and a list of selected papers in which the respective indices are applied is set out in Table 6.

Considering the broad spectrum of stakeholders interested in creating and applying digital economy indices, it is not surprising that individual digital economy indices have different roles and levels of importance in scientific research. Figure 2 sets out the distribution of digital economy indices by the number of published scientific articles in which the indices are applied. It can be noticed that the DESI index is the most represented and applied in scientific research, followed by the NRI index and the EGDI index.

Figure 2. Distribution of Digital Economy Indices by the Number of Published Articles



Source: Web of Science database.

Also, some indices were not primarily created for scientific purposes and, therefore, are rarely used in scientific papers, such as the Information Society Index (ISI), the Digital Access Index (DAI), and the ICT Development Index. A comparative analysis of the structure of e-indices and an assessment of their coherence were made in Kononova's study (2015). Considering the comprehensiveness of the information contained in each individual index, Kononova (2015) especially emphasizes the importance of the availability and reliability of the data used to calculate the individual index. Considering the representation and significance of the presented indices in scientific research (Figure 2), in the next sections of this study, the focus will be on the following indices: Digital Economy and Society Index (DESI), Networked Readiness Index (NRI), E-Government Development Index (EGDI), Peking University Digital Financial Inclusion Index (PKU-DFII), Technology Achievement Index (TAI), and Digital Opportunity Index (DOI).

Table 6. An Overview of Digital Economy Indices

Index	Publisher	First publication	Countries covered	Short description	Selected papers
Digital Economy and Society Index (DESI)	European Commission	2014	27	DESI is an index that summarises indicators of Europe's digital performance and tracks the progress of EU countries. On an annual basis, it monitors the performance of member states in digital connectivity, digital skills, online activity, and digital public services.	Liu (2022); Laitsou et al. (2020); López Peláez et al. (2020); Stavytskyy et al. (2019); Elmassah and Hassanein (2022); Li et al. (2020); Borowiecki et al. (2021); Banhidi and Dobos (2023); Olczyk and Kuc-Czarnecka (2022); Kovács et al. (2022); Volkova et al. (2021); Ershova et al. (2021); Esses et al. (2021)
Digital Access Index (DAI)	International Telecommunication Union (ITU)	2003	181	DAI is an index that measures the overall ability of individuals in a country to access and use new ICTs. It is based on four fundamental variables: infrastructure, affordability, knowledge and quality, and actual usage of ICTs.	Nauriyal and Bhalla (2006); Kononova (2015)
Digital Opportunity Index (DOI)	International Telecommunication Union (ITU)	2005	181	The DOI index is a standard analytical tool for measuring the digital divide and comparing ICT performance within and across countries. This index summarises 11 ICT indicators grouped into three clusters: opportunity, infrastructure, and utilization.	James (2007); Kelly and Biggs (2007); Haider et al. (2021); Hanafizadeh et al. (2009); James (2008)
E-Government Development Index (EGDI)	United Nations	2002	193	The EGDI index is used for the analysis of e-government development of UN member states. It includes three variables: provision of online services, telecommunication connectivity, and human capacities.	Yarovoy et al. (2020); Zhao et al. (2022); Bilal (2017); Aniscenko et al. (2017); Osman and Zablith (2021); Ullah et al. (2021); Yerina et al. (2021); Surjit and Das (2020); Vysochyna et al. (2021); Whitmore (2012)
ICT Development Index	International Telecommunication Union (ITU)	2009	154	The IDI index was used for the analysis of the developments in information and communication technology (ICT) among countries. It included 11 indicators and was published from 2009 to 2017.	Sukhodolov and Popkova (2018); Zanizdra et al. (2021); Alibekova et al. (2020); Lomakina et al. (2021)
ICT Diffusion Index	United Nations Conference on Trade and Development (UNCTAD)	2003	180	The ICT Diffusion Index was used for the analysis of ICT diffusion across countries. It included 8 indicators grouped into two clusters: connectivity and access. This index was later abandoned in favour of the ICT Opportunity Index.	Kononova (2015), Kallal et al. (2021)

Table 6. Cont.

ICT Opportunity Index (ICT-OI)	International Telecommunication Union (ITU)	2009	183	Besides the DOI index, the ICT-OI index is a useful analytical tool. The DOI index is based on three clusters: opportunity, infrastructure, and utilization, and uses the arithmetic average score measurement, whereas the ICT-OI index is measured using a geometric mean and focuses more on conventional ICT.	Emrouznejad et al. (2010); Atici (2010); Szabó and Chiriac (2016)
Information Society Index (ISI)	International Data Corporation (IDC)	1997	53	The ISI index measures the country's ability to access and absorb information and information technology. It summarises 15 variables arranged into four subindices.	Kononova (2015)
Networked Readiness Index (NRI)	World Economic Forum	2002	131	NRI is an index that is used for the analysis of the degree of readiness of countries to exploit opportunities offered by information and communications technology. It includes 58 indicators distributed in four dimensions: technology, people, governance, and impact.	Kirkman et al. (2002); Petrenko et al. (2017); Spivakovskyy et al. (2021); Wu et al. (2012); Moroz (2017); Samoilenko and Osei-Bryson (2019); Yera et al. (2020); Zelenkov and Lashkevich (2020); Petkova et al. (2019); Topornin et al. (2021); Vysochyna et al. (2021)
Peking University Digital Financial Inclusion Index (PKU-DFII) of China	Institute of Digital Finance at Peking University	2011	1	PKU-DFII is an index that is used for the analysis of digital finance in China. This index represents a sort of upgrade of the financial inclusion index proposed by the World Bank. It includes three variables: breadth of coverage, depth of usage, and level of digitization.	Guo et al. (2020); Yang and Zhang (2020); Chen and Zhang (2021); Wang (2022); Huiyuan and Xiaomin (2021); Rao et al. (2022); Xin et al. (2022); Zhao and Feng (2022)
Technology Achievement Index (TAI)	Desai et al. (2002)	2002	167	TAI is an index that calculates the country's skills concerning the latest technologies, such as work skills, innovation skills, etc. It was originally developed by Desai et al. (2002). The first version of the index was well-known as TAI-02. Following TAI-02, TAI-09 and TAI-15 were proposed. While TAI-02 analysed 72 countries, TAI-09 investigated 91 countries, and TAI-15 analysed 167 countries (Incekara et al., 2017).	Desai et al. (2002); Cherchye et al. (2008); Nasir et al. (2009); Márquez-Ramos and Martínez-Zarzoso (2010); Burinskienė and Pipirienė (2014); Ali et al. (2015); Incekara et al. (2017)

Source: Author's systematization.

4.2. Methodology Development

Section 4.2, Methodology Development, begins with detailed insight into existing measurement approaches and later continues with an overview of the latest research and scientific contributions in the field of digital economy indices development.

4.2.1. Existing Measurement Approaches

The methodological tools for analysing the digital economy have evolved with information and communication technology (ICT). Considering the wide range of users interested in the results of the development of the digital economy, the development of the methodology for monitoring the digital economy is a matter of interest not only for the scientific community but also for other stakeholders in society (the business sector, financial institutions, the telecommunications sector, technology parks, investors, etc.). This additionally emphasizes the importance of developing an appropriate methodological framework, such as the digital economy indices. Several indices of the digital economy have been profiled in scientific research in the last 20 years. They have found their application primarily as a methodological basis in conducting empirical research (Vidruska, 2016; Aniscenko et al., 2017; Incekara et al., 2017; Jurcevic et al., 2020; Liu, 2022; Olczyk & Kuc-Czarnecka, 2022; Ogrean & Herciu, 2022).

At the same time, some indices have disappeared and are no longer calculated, while some new indices of the digital economy have appeared. Also, there are indices of the digital economy that changed their name as they improved. Improving the methodology in terms of the construction, calculation, and interpretation of individual indices of the digital economy induces the increasing interest of researchers. Today's role and significance of the digital economy require continuous methodological improvements. Thereby, researchers are endeavouring to remove the existing methodological limitations of individual indices (Archibugi & Coco, 2004; Fathey & Othman, 2013; Rath, 2016; Jovanović Milenkovic et al., 2016; Ojanperä et al., 2019; Stanković et al., 2021; Olczyk & Kuc-Czarnecka, 2022).

Of the digital economy indices analysed, the DESI, NRI, and EGDI indices are the most used in scientific research today (Figure 2). In addition to the mentioned indices, the DOI, TAI, and PKU-DFII indices have also played a more significant role in scientific research in the last 20 years. A more detailed description of the basic methodological features of the selected digital economy indices, including main dimensions, total indicator count, and range of indices, is set out in Table 7.

Also, it seems particularly important and useful to analyse the advantages and limits of a particular index of the digital economy (Table 8).

Table 7. Basic Methodological Features of the Selected Digital Economy Indices

Index name	Network Readiness Index	Digital Economy and Society Index	E-Government Development Index
Abbreviation	NRI	DESI	EGDI
Main dimensions	Environment (25%), readiness (25%), usage (25%), impact (25%)	Connectivity (25%), human capital (25%), use of the internet (15%), integration of digital technology (20%), digital public services (15%)	Provision of online services (33%), telecommunication connectivity (33%), human capacity (33%)
Total indicator count	54	30	3
Countries included	Worldwide, 143 (NRI 2015)	EU-28 countries (DESI 2016) and candidates	All 193 United Nations member states
Maintained by	World Economic Forum	European Commission	United Nations
Possible range of index	0–100	0–1	0–1
Period available	2003–2022	2013–2022	2003–2022
Index name	Peking University Digital Financial Inclusion Index	Technology Achievement Index	Digital Opportunity Index
Abbreviation	PKU-DFII	TAI	DOI
Main dimensions	Breadth of coverage (54.0%), depth of usage (29.7%), level of digitalization (16.3%)	Technology creation (25%), diffusion of recent innovations (25%), diffusion of old innovations (25%), human skills (25%)	Opportunity (33%), infrastructure (33%), utilization (33%)
Total indicator count	33	8	11
Countries included	The People's Republic of China	Worldwide, 179 (TAI-20)	Worldwide, 181 countries
Maintained by	Institute of Digital Finance at Peking University	United Nations Development Programme (UNDP)	International Telecommunication Union (ITU)
Possible range of index	It captures information on various aspects of financial inclusion, where 0 represents complete financial exclusion. The minimum index value is 0. The higher the index value, the higher the level of digital financial inclusion.	The countries included in the TAI index are divided into four sub-groups called leaders (TAI > 0.5), potential leaders (TAI = 0.35–0.49), dynamic adopters (TAI = 0.20–0.34), and marginalized (TAI < 0.20) (Desai et al., 2002).	The Digital Opportunity Index aims to measure the ease of access that citizens have to information and communication technologies (ICT), in terms of both availability and price, on a scale that ranges from zero, representing a total lack of ICT access, to one, representing full ICT access.
Period available	2011–2018	2000–2018	2004–2006

Source: Author's systematization.

Table 8. Advantages and Limits of Alternative Digital Economy Indices

Index	Advantages	Limits
Digital Economy and Society Index (DESI)	The DESI index is used for the analysis of Europe's overall digital performance as well as its digital competitiveness. It is a measurement system that is widely used and quoted by scholars, experts, and policymakers. The main advantage of this index is that it is measured in 28 countries and by doing so allows comparison between them. The DESI index ensures a complete picture of the digital ecosystem in the EU and member countries. A separate dataset (International Digital Economy and Society Index, I-DESI) aims to extend the results of DESI to 17 non-EU countries.	Since measurements are collected in 28 different countries, the methodology is determined to be general and applicable in all countries. Therefore, the results are also general and unsuitable for deep analysis and explanation of certain phenomena. The time between the data collection and publication is often very long, frequently resulting in outdated assessments. Indicators and sub-indicators change year by year, making comparing time series performances difficult because these corrections are not emphasized enough. There are also significant differences between the statistical offices and data collection methods between countries.
Networked Readiness Index (NRI)	The NRI index is a useful analytical tool for the analysis of the digital development of countries. This index is one of the most comprehensive assessments of ICT readiness and has been used by an increasing number of governments as a basis for their national ICT strategies. In contrast to the 28 countries covered by the Digital Economy and Society Index (DESI) of the European Union, which measures only the most developed countries, the NRI index indicates the digital development of 130 countries around the world. The NRI index is based on four fundamental variables: technology, people, governance, and impact. It covers issues ranging from future technologies such as artificial intelligence to the role of digital technologies in achieving the sustainable development goals.	The NRI index's limitations can be divided into several dimensions: missing values, reference year, normalization factor, and consistent data collection. Missing values: The NRI index represents relative index scores, which implies that a missing value for one country affects the index score of other countries. Reference year: The data underlying the NRI do not refer to a single year but several years, depending on the latest available year for any given variable. In addition, the reference years for different variables are not the same for each country due to measures to limit the number of missing data points. Normalization factor: Most NRI variables are normalized using GDP, population, or other factors with the intention of enabling cross-economy comparability. However, this implies that year-on-year changes in individual indicators may be driven either by the variable (numerator) or by its normalization factor (denominator). Consistent data collection: Analysing the change in year-on-year performance is based on consistent data collection through the years. Modifications of variables or the data collection process could produce changes in the ranking of countries that do not reflect the actual state of their digital development.
Peking University Digital Financial Inclusion Index (PKU-DFII) of China	The PKU-DFII index measures the development of digital financial inclusion in different regions in the People's Republic of China. It contains useful information for scholars, regulators, and industry insiders.	Due to the lack of comparable data, it is not entirely possible to get a comprehensive picture of digital financial inclusion across all of China's regions. Also, this index was constructed only for the regions of China, which excludes international comparability and significance of this index on a global level.

Table 8. Cont.

Index	Advantages	Limits
E-Government Development Index (EGDI)	E-government services provide a range of benefits, such as enabling efficient, low-cost, and transparent services to citizens and the business sector through integrating and sharing knowledge and resources (Janowski, 2015; Sivarajah et al., 2015). Therefore, it is important to establish and continuously improve the analytical framework for analysing the effectiveness of e-government services. One of the most important analytical tools for the analysis of the state of e-government development progress is the EGDI index.	Despite the wide application of the EGDI index, there are numerous scholars who emphasize the limitations of the EGDI index. For example, Whitmore (2012) suggests a modification in calculating the EGDI index by using factor analysis. Kabbar and Dell (2013) suggest the inclusion of the gross domestic product (GDP) variable in the calculation of the EGDI index. They argue that the adjusted EGDGDP provides a better assessment of a countries' e-government development as it measures the country's performance relative to what would be expected of that country in terms of GDP rather than the absolute measure currently given to each country.
Technology Achievement Index (TAI)	The TAI index implements two standardized indicators to assess the extent of innovation in the nation. One of these indicators is the exact number of patents granted per capita, which informs economists about the current status of actions. The other is royalty receipts, which are accompanied by license charges from foreign countries per capita. This is an effective statistic that helps us assess the relevance of qualified past innovations. The TAI index provides insightful knowledge on the frequency and pattern at which innovative practices, theories, or manufactured items gain popularity among a certain community.	The TAI index is primarily oriented on outputs rather than inputs such as numbers of scientists, R&D expenditures, or policy environments. In the calculation of the TAI index, all indicators in a particular dimension have equal weight. Also, the dimensions have equal weight in the final index (one quarter). This means higher performance in one area can compensate for weakness in another, improving the overall ranking and making a country rank among a different class of countries than where it actually belongs.
Digital Opportunity Index (DOI)	The DOI index is widely used. It is calculated for 181 countries of the world. This includes both poor and rich countries. Eleven indicators are included in the calculation of the DOI index. Because of its wide application, simplicity, and availability, the DOI index has become a standard analytical tool that researchers, governments, operators, and others use to analyse the digital divide and ICT performance between countries.	Limitations of the DOI index include a lack of data for the analysis of ICT infrastructure and access, and the use of equal weighting or experts' opinions to aggregate the indicators. Another issue is insufficient methodological harmonization between countries, which is manifested in the method of data collection, classification, and processing. This ultimately reduces and limits the quality of interpretation of the obtained index values for individual countries.

Source: Author's systematization.

In this regard, some common features for all indices can be extracted based on the presentation of the advantages and limitations of individual indices of the digital economy. The contribution of digital economy indices in scientific research stems from identifying the new trends in digitalization of the economy, the causes of positive changes in digital development, as well as differences in the degree of digitization of individual countries. In addition, they are often easily interpreted. The advantages of using digital economy indices are often closely related to their disadvantages. One of the main limitations of these indices is the oversimplification of complex interrelations, i.e., they reduce the digital development to a single value, which in some cases could lead to wrong conclusions (Vehovar et al., 2006). Furthermore, a continuous problem of the digital economy indices is related to the variables involved in designing and calculating the individual indices (Cruz Jesus et al., 2012). The problem of including certain variables in the index stems from the fact that accelerated technological development brings the need to include new variables in the index and exclude some existing ones. Related to that issue, the always present limitation is how to determine the weight of individual variables included in calculating the index. Ultimately, the weight of an individual variable can significantly determine the final value of the composite index and influence the interpretation of the results obtained.

The aforementioned limitations have motivated numerous researchers to improve the existing methodological framework and the digital economy indices (Wong et al., 2009; Gaaloul & Khalfallah, 2014; Corrocher & Ordanini, 2002).

Wong et al. (2009) emphasized the disadvantage of the digital economy indices in terms of the exclusion of certain social groups from the information society (such as the elderly and those on a low income). Therefore, these authors proposed a new digital index to analyse the degree of inclusion of different disadvantaged groups in an information society.

Gaaloul and Khalfallah (2014) highlighted the dependence of the values of digital economy indices on the weighing scheme used to aggregate individual indicators or sub-indicators, which can affect the credibility of the index. They proposed revaluating the Digital Access Index by applying the data envelopment analysis approach to overcome these limits. Bedford (2013) developed a new knowledge economy index based on a more holistic and balanced view of a knowledge society.

Corrocher and Ordanini (2002) emphasized the limitations of the methodological framework in the analysis of the digital divide. Therefore, these authors created a new methodology for measuring the digital divide within a set of countries or geographical areas. A new synthetic index of digitalization was developed that includes the factors of digitalization as follows: communication infrastructure, human resources, competitiveness of the information and communication providers, degree of competition among different operators, market diffusion, and size of the digital market. The new synthetic digitization index made it possible to assess the digital divide between different countries and geographical areas.

In addition to Corrocher and Ordanini (2002), other authors have contributed to the development of the methodological framework in the field of the digital divide (Cruz Jesus et al., 2012; Park et al., 2015). Cruz Jesus et al. (2012) analysed the digital divide across the European Union. Using principal components analysis, they constructed an original index of digitalization. Exploring the digital divide in a sample of 108 countries, Park et al. (2015)

created a new ICT development index. The methodological framework was based on applying the method of principal components and including conventional ICT development indicators.

4.2.2. Ongoing Research

Recently, the development of digital economy indices has been the subject of interest of numerous researchers (Chen & Wu, 2022; Luo & Zhou, 2022; Li et al., 2021; Wang et al., 2022; Bai et al., 2022; Wang et al., 2022; Popov & Semyachkov, 2020; Wang et al., 2022; Ojanperae et al., 2019; Toh Hao et al., 2022; Ferracane & van der Marel, 2020; Goh, 2021). Applying data on provinces in China for the period from 2012 to 2018, Chen and Wu (2022) constructed a new index for the analysis of China's provincial digital economy. The index consists of six dimensions: digital infrastructure construction level, digitalization level of the society advanced by ICT, digital technology innovation capability, economic growth promoted by ICT, development level of emerging digital economy industries, and capitalization level of digital economy enterprises. To create the weights for these dimensions, Chen and Wu (2022) applied the CRITIC methodology (Yalçin & Ünlü, 2018). The following equation gives the weights:

$$W_i = \frac{C_i}{\sum_j^n C_i} \quad i = 1, 2, \dots, n$$

$$C_i = \delta_i \sum_j^n (1 - R_{ij}) \quad i = 1, 2, \dots n, \; i \neq j$$

where δ_i denotes the standard deviation of indicator *i* and R_{ij} denotes the correlation coefficient between indicator *i* and indicator *j*.

Luo and Zhou (2022) emphasize the lack of a unified evaluation index system for the digital economy. Therefore, they developed a digital economy evaluation index, which consists of four dimensions: digital infrastructure, digital industry scale, innovation capability, and digital inclusive finance. Each of these dimensions includes appropriate digital indices such as the number of broadband internet users per 10,000 people, the number of mobile phone users per 10,000 people, per capita telecom business volume (Yuan), the number of patents in key industries of the digital economy, etc. The proposed index was tested on a sample of 31 Chinese provinces from 2011 to 2020. After Luo and Zhou (2022) defined the dimensions and appropriate indices, they eliminated the influence of dimensionality using the range standardization method. In the next step, the entropy weight method was used to calculate the weight of each index. Finally, the authors used the weighting method to explore the development of the digital economy in China's provinces. The equations are as follows:

$$A_{ij} = \frac{X_{ij} - min(X_{ij})}{max(X_{ij}) - min(X_{ij})}$$

$$P_{ij} = \frac{A_{ij}}{\sum_{i=1}^n A_{ij}}$$

$$e_j = -\left(\frac{1}{ln(n)}\right) \sum_{i=1}^n P_{ij} ln(P_{ij})$$

$$\omega_j = \frac{1 - e_j}{\sum_{j=1}^m (1 - e_j)}$$

$$F = \sum_{j=1}^m \omega_j \times A_{ij}$$

where X_{ij} denotes the original values, and A_{ij} denotes the normalized values. P_{ij} represents the proportion of the *i*th province in the *j*th index. At the same time, e_j denotes the information entropy, ω_j is the weight of the *j*th index, and *F* denotes the digital economy development level.

To overcome the methodological gap in the analysis of the effects of the digital economy on environmental quality, Li et al. (2021) constructed a comprehensive development index of the digital economy and environment. Their contribution to methodology development is extremely important due to the increasing interest of researchers to contribute to science with empirical studies on the topic of digital economy and environment. In developing a comprehensive index, Li et al. (2021) first proposed the key elements of the index structure (dimensions, indices). They divided the digital economy into three dimensions: digital infrastructure, digital talent, and digital industry value. The dimensions of environmental quality are as follows: ecological environment, resource consumption, and environmental conservation. Besides the three dimensions, the authors proposed nine indices for the digital economy and 13 indices for environmental quality. As in the study of Luo and Zhou (2022), Li et al. (2021) used the entropy weight method to obtain the weight of each indicator. The construction procedure of the comprehensive development level index of the digital economy and environment is divided into several steps:

- Normalize the index data to obtain the normalized data u_{ij}^n

  Positive index: $u_{ij}^n = \left[\frac{u_{ij} - \min u_{ij}}{\max u_{ij} - \min u_{ij}}\right] \times 0.9 + 0.1;\ \ 1 \le i \le n$

  Negative index: $u_{ij}^n = \left[\frac{\max u_{ij} - u_{ij}}{\max u_{ij} - \min u_{ij}}\right] \times 0.9 + 0.1;\ \ 1 \le i \le n;$

- Calculate the proportion of indices: $p_{ij} = \frac{u_{ij}^n}{\sum_{i=1}^n u_{ij}^n}$;

- Calculate the entropy value of index *j*: $e_j = -\left(\frac{1}{ln(n)}\right)\sum_{i=1}^n p_{ij} ln(p_{ij})$;

- Calculate the difference coefficient of the *j* index and obtain the weight;

- Calculate the coefficient of difference: $\omega_j = \frac{1-e_j}{\sum_{j=1}^m (1-e_j)}$;

- $U_i = \sum_{j=1}^m \lambda_{ij} u_{ij}^n$ represents the function of two subsystems (digital economy and environmental quality) composed of three dimensions in each subsystem. In addition, there are 22 indices in total, distributed in a way that 9 indices are included in the digital economy, and 13 indices are included in environmental quality. The weight of an individual index is denoted as λ_{ij} .

Based on the existing *n*-dimensional system interaction coupling model:

$$C_n = n \times \sqrt[n]{\frac{U_1 U_2 \ldots U_n}{(U_1 + U_2 + \cdots U_n)^n}}$$

the authors derived the two-dimensional coupling function for the digital economy and environmental quality:

$$C_2 = 2 \times \sqrt[2]{\frac{U_1 U_2}{(U_1 + U_2)^2}}$$

The study by Li et al. (2021) takes n = 2, C denotes the coupling degree between the digital economy and environmental quality, and its value is between 0 and 1.

When C tends to 0, the coupling system composed of the digital economy and environment is in a coupling-detuned state. When C tends to 1, the coupling system composed of the digital economy and environment is in a high-quality coupling state. The degree of coupling can effectively reflect the strength of action between the digital economy and the environment, but this function also has shortcomings. It cannot fully reflect the overall function and comprehensive, coordinated development level of the digital economy and the environment. It cannot match the actual economic significance between U_1 and U_2. Therefore, this study establishes the coupling coordination degree function as follows:

$$D = \sqrt{C \times T}$$
$$T = \alpha U_1 + \beta U_2$$

where T denotes the comprehensive development level index of the digital economy and environment, C represents the degree of coupling, and α and β are undetermined coefficients.

Several other studies also contributed to the methodology development related to the digital economy and environment (Wang et al., 2022; Bai et al., 2022; Wang et al., 2022; Popov & Semyachkov, 2020; Wang et al., 2022). Wang et al. (2022) proposed a comprehensive digital economy index for the purpose of analysing the role of the digital economy in the development of a low-carbon society. The research was conducted on a sample of 30 provinces in China for the 2006–2017 period. Analysing the effects of the digital economy on environmental quality, Bai et al. (2022) concluded that the existing literature is deficient on how the digital economy affects urban environmental pollution. To fill this gap, these authors developed an urban digital economy index system. In the analysis of the role of the digital economy in green innovation, Wang et al. (2022) constructed a comprehensive digital economy index. Popov and Semyachkov (2020) proposed an index methodology for assessing the digitalization of the urban environment. Exploring the link between digitalization and carbon emissions, Wang et al. (2022) proposed a new digitalization index. In the construction of the index, they employed the entropy value method and spatial Markov chain. Analysing the implications of the digital economy on urban innovation, Huang et al. (2022) developed a digital economy index. The index construction was based on city-level data from China. Chen et al. (2022) created an evaluation index system of digital economy development. The quality of the index was estimated by using the entropy method. Ojanperae et al. (2019) proposed the development of a Digital Knowledge Economy Index based on the usage of traditional and novel data sources (GitHub).

To analyse the digital performance of Malaysia, Toh Hao et al. (2022) developed a digital economy index. Index construction was based on the sample of Malaysia in the 2000–2018 period. The proposed index consists of four dimensions: infrastructure, empowering society, innovation and technology adoption, and jobs and growth.

Ferracane and van der Marel (2020) created the Digital Platform Restrictiveness Index (DPRI)

as a measure of restrictiveness for online platforms. Considering the restrictiveness of each policy measure applied by a country, the DPRI index quantifies the trade cost position with respect to digital platform policies of an individual country. Goh (2021) proposed a new digital readiness index, which aims to assess leading arbitral institutions on their level of digital readiness. The new index consists of five indicators: case filing and management, arbitrator panel, meetings/hearings, security, and thought leadership.

4.3. Empirical Findings

Empirical research on the digital economy in the last two decades has attracted an increasing interest of researchers (Liu, 2022; Stavytskyy et al., 2019; Rakicevic et al., 2019; Li et al., 2020; Cruz Jesus et al., 2012; Park et al., 2015; Borowiecki et al., 2021; Imran et al., 2022; Karnitis et al., 2019; Skare et al., 2023; Milashovska et al., 2022; Melnychenko et al., 2021; Elmassah & Hassanein, 2022; Volkova et al., 2021; Banhidi & Dobos, 2023; Noja et al., 2022; Moroz, 2017; Wang et al., 2022; Wu et al., 2023; Shen & Zhang, 2022; Han et al., 2022; Lomakina et al., 2021; Marshall et al., 2020; Alfonso & Pariso, 2021; Szabolcs et al., 2022; Wang & Shi, 2021; Huang et al., 2022; Lyu et al., 2023; Chen et al., 2022; Chen & Wu, 2022). The indices of the digital economy (EGDI, DESI, NRI, TAI, PKU-DFII, DOI), on which the methodological basis of empirical research is based, have a special role and importance. As digitization affects all economic areas, so is there a wide spectrum of empirical research in which digital economy indices find their application (Grinberga-Zalite & Hernik, 2019; Banhidi et al., 2020; Olczyk & Kuc-Czarnecka, 2022; Basol & Cumhur Yalçin, 2021; Kovács et al., 2022; Jovanović et al., 2018; Vidruska, 2019; Spivakovskyy, 2021; Jovanović et al., 2016; Wu et al., 2012; Yera et al., 2020; Yarovoy et al., 2020; Aniscenko et al., 2017; Wang, 2022; İncekara et al., 2017). A significant part of scientific research is continuously focused on digitalizing public administration (Surjit & Das, 2020; Dobrolyubova, 2021; Stofkova et al., 2022). In doing so, the degree of digitization, as well as the availability and efficiency of public services, is analysed (Todoruț, 2018; Ullah et al., 2021; Verkijika & De Wet, 2018). In analysing the success of digitization of the economy, authors often make comparisons between countries. With the construction and development of the DESI index, this has become particularly evident in the case of the European Union countries (Stavytskyy et al., 2019; Borowiecki et al., 2021; Soava et al., 2022; Liu, 2022). Observing the effects of digitization on macroeconomic variables, as could be expected, the largest part of the research is devoted to the effects of digitization on economic growth (Olczyk & Kuc-Czarnecka, 2022; Fernández-Portillo et al., 2020; Ivanović-Đukić et al., 2019; Vyshnevskyi et al., 2021; Zhao et al., 2022). The construction and development of the Digital Financial Inclusion Index by Peking University facilitated the implementation of empirical research on the effects of digitalization on financial inclusion (Yang et al., 2020; Zhou et al., 2022). The largest number of these studies was conducted on a sample of Chinese provinces (Zou et al., 2021; He et al., 2022). The processes of digitization of the economy are closely linked to innovation. Therefore, the effects of the digital economy on innovation are inducing an increasing interest of researchers (Martínez et al., 2022; Pan et al., 2022; Rao et al., 2022; Xu & Li, 2022). The latest research is particularly focused on the effects of digitization on the environment (Shen et al., 2022; Guo et al., 2022). Some researchers investigate the contribution of digitization to the development of the competitiveness of the economy (Laitsou et al., 2020; Hurduzeu et al., 2022; Stanković et al., 2021).

A classification of key empirical findings is presented in Table 9.

Table 9. Classification of Empirical Findings

Subject of research	Title of the paper	Author/s	Year of publication	Empirical findings
Digitalization of public services	Digital technologies and the modernization of public administration	Todoruț, A. V.; Tselentis, V.	2018	It is proved that the rapid development of technologies enables an increasing variety and sophistication of online services.
	The role of e-governance in combating COVID-19 and promoting sustainable development: A comparative study of China and Pakistan	Ullah, A.; Pinglu, C.; Ullah, S.; Abbas, H. S. M.; Khan, S.	2021	It is confirmed that by adopting China's e-governance model, the Government of Pakistan will be able to improve public services for citizens and the business sector in terms of better coordination, standardization of services, creation of synergies, and realization of cost-effectiveness.
	Accessibility and usability analysis of Indian e-government websites	Surjit, P.; Daqs, S.	2020	A need to improve the overall accessibility and usability of India's e-government websites has been identified.
	A usability assessment of e-government websites in Sub-Saharan Africa	Verkijika, S. F.; De Wet, L.	2018	The paper evaluates 279 e-government websites from 31 Sub-Saharan African countries, and confirms that most e-government websites are poorly usable. The average usability score for the websites is 36.2%, with the most usable website having a score of only 64.8%. The usability of e-government websites is positively correlated with the EGDI index.
	Investigations concerning e-government adoption in transition economies	Szabó, Z. K.; Chiriac, L.	2016	It is confirmed that there is a very strong positive correlation between the level of e-government development and e-participation. There is a huge gap between the availability of online public services and the usage level.
Comparison of digital transformation in the European Union	Digital policy in European countries from the perspective of the Digital Economy and Society Index	Liu, T.-C.	2022	Germany, Luxembourg, and the United Kingdom confirm a high level of internet service use. Countries that are more correlated with the use of digital public services include Belgium, Sweden, Denmark, Norway, the Netherlands, Lithuania, and Malta. Countries with stronger human capital performance include Austria, Estonia, Portugal, and Spain, followed by the Czech Republic, France, and Slovenia.
	The analysis of the Digital Economy and Society Index in the EU	Stavytskyy, A.; Kharlamova, G.; Stoica, E. A.	2019	The analysis conducted on a sample of the European Union countries confirms the hypothesis that a 1% growth in the consumption index results in about a 0.2 increase in the Digital Economy and Society Index (DESI), and an increase in unemployment by 1% leads to about a 0.2 DESI decrease.
	Developing digital economy and society in the light of the issue of digital convergence of the markets in the European Union countries	Borowiecki, R.; Siuta-Tokarska, B.; Maron, J.; Suder, M.; Thier, A.; Zmija, K.	2021	It is confirmed that the EU-28 countries are undergoing a convergence process in digital development. The convergence is noticed in the following areas: connectivity, human capital, use of internet services, and digital public services.
	Analysis and forecast of the use of e-commerce in enterprises of the European Union states	Soava, G.; Mehedintu, A.; Sterpu, M.	2022	The share of companies performing e-commerce depends on the size of enterprises. A significant growth in e-commerce in most European countries is forecast in the upcoming period.

Table 9. Cont.

Subject of research	Title of the paper	Author/s	Year of publication	Empirical findings
The effects of digitalization on economic growth	Digital transformation and economic growth – DESI improvement and implementation	Olczyk, M.; Kuc-Czarnecka, M.	2022	Connectivity has the largest impact on digital development in EU countries. Digitalization is a statistically significant variable explaining changes in GDP per capita.
	Impact of ICT development on economic growth	Fernández-Portillo, A.; Almodóvar-González, M.; Hernández-Mogollón, R.	2020	ICT drives economic growth within the framework of developed European economies.
	Does digitalization affect the contribution of entrepreneurship to economic growth?	Ivanović-Đukić, M.; Stevanović, T.; Rađenović, T.	2019	Average growth expectation entrepreneurship and new products entrepreneurship have the greatest contribution to economic growth in the EU regions with lower levels of digitization. At the same time, high growth expectation entrepreneurship and new technology development entrepreneurship have a dominant role in economic growth in the EU regions characterized by a higher degree of digitization.
	Economic growth in the conditions of digitalization in the EU countries	Vyshnevskyi, O.; Stashkevych, I.; Shubna, O.; Barkova, S.	2021	The digitalization of the economy at the present stage of technology and institution development in European Union countries does not have a decisive impact on economic growth.
	Dynamic influence of digital and technological advancement on sustainable economic growth in Belt and Road Initiative (BRI) countries	Zhao, S.; Zhang, Y.; Iftikhar, H.; Ullah, A.; Mao, J.; Wang, T.	2022	Improvements in the EGDI index, high-tech exports, internet users' growth, and reductions in unemployment would increase sustainable economic growth in all Asian countries of the Belt and Road Initiative (BRI).
Testing of digital financial inclusion	Digital financial inclusion and sustainable growth of small and micro enterprises—Evidence based on China's New Third Board Market listed companies	Yang, L.; Zhang, Y.	2020	In the circumstances of high-quality development of China's economy, the improvement of digital financial inclusion and transforming of the ecological pattern of the financial industry can deliver steady financial support for the sustainable growth of small and micro enterprises and ensure the healthy development of micro enterprises.
	Does the level of financial cognition affect the income of rural households? Based on the moderating effect of the Digital Financial Inclusion Index	Zou, F.; Li, T.; Zhou, F.	2021	The advancement of the financial cognitive level stimulates the increase of rural household income. This increase has significant variations at different quantile levels of income.
	The impact of digital inclusive finance on provincial green development efficiency: Empirical evidence from China	He, Z.; Chen, H.; Hu, J.; Zhang, Y.	2022	Digital inclusive finance can significantly improve provincial green development efficiency.
	Will digital financial inclusion increase Chinese farmers' willingness to adopt agricultural technology?	Zhou, Z.; Zhang, Y.; Yan, Z.	2022	Digital financial inclusion significantly increases farmers' willingness to adopt agricultural technology.

Table 9. Cont.

Subject of research	Title of the paper	Author/s	Year of publication	Empirical findings
The digital divide across countries	Club convergence and factors of digital divide across countries	Park, S. R.; Choi, D. Y.; Hong, P.	2015	The factors that drive a country's digitalization convergence are identified: GDP per capita, the share of service trade in GDP, the urban population ratio, and the tertiary education entrance rate.
	Digital divide across the European Union	Cruz Jesus, F.; Oliveira, T.; Bação, F.	2012	It is confirmed that there is a digital gap within the European Union. European integration processes and economic wealth contribute significantly to the digital divide.
Digitalization and competitiveness	Digital competitiveness in the European Union era: The Greek case	Laitsou, E.; Kargas, A.; Varoutas, D.	2020	The results confirm Greece's low state of digitization. The reasons for the lag lie on the demand side (businesses that consume internet services) and the offer side (institutional and governmental constraints).
	The interplay between digitalization and competitiveness: Evidence from European countries	Hurduzeu, G.; Lupu, I.; Lupu, R.; Ion Filip, R.	2022	When Western European countries are compared with Central and Eastern European countries, the export of goods is the commonest indicator that is most significantly influenced by the DESI index. Another indicator that reacts positively to digitalization for both groups of countries is skilled labour.
	The digital competitiveness of European countries: A multiple-criteria approach	Stanković, J. J.; Marjanović, I.; Drezgić, S.; Popovic, Ž.	2021	The Nordic countries are confirmed as having the highest digital competitiveness. At the same time, most Eastern European countries still lag behind.
The effects of the digital economy on the environment	Digital economy and ecological performance: Evidence from a spatial panel data in China	Shen, X.; Zhao, H.; Yu, J.; Wan, Z.; He, T.; Liu, J.	2022	Although the impact of the digital economy on ecology in China has decreased over time, it has still had a significant positive effect. Also, the effect of the digital economy on ecology in China shows regional heterogeneity and is more emphasized in developed regions.
	Exploring the mechanism of the impact of green finance and digital economy on China's green total factor productivity	Guo, J.; Zhang, K.; Liu, K.	2022	The digital economy has a significant impact on green total factor productivity. The green finance and digital economy's contribution to green total factor productivity is mainly derived from technological progress.
The impact of the digital economy on innovation	Digitalization, innovation and environmental policies aimed at achieving sustainable production	Martínez, J. M. G.; Puertas, R.; Martín, J. M. M.; Ribeiro-Soriano, D.	2022	Europe has not yet been able to break the negative link between GDP and sustainability, despite the positive impact of all facets of digitalization, innovation, and environmental policies.
	Digital economy: An innovation driver for total factor productivity	Pan, W.; Xie, T.; Wang, Z.; Ma, L.	2022	The digital economy index has a positively nonlinear relationship with provincial total factor productivity in China. It is confirmed that the digital economy acts as an innovation driver for the extensive and sustainable development of total factor productivity.
	Digital finance and corporate green innovation: Quantity or quality?	Rao, S.; Pan, Y.; He, J.; Shangguan, X.	2022	The promotional impact of digital finance on corporate green innovation was confirmed in state-owned, eastern, and mature enterprises. Digital finance makes firms more transparent and funds flow more convenient.
	The impact of the digital economy on innovation: New evidence from panel threshold model	Xu, J.; Li, W.	2022	The promoting impact of the digital economy on innovation enhances with the optimization of industrial structure or the advancement of urbanization level.

Source: Author's systematization.

4.4. Research Agenda

This section is a proposal of several scientific phases that can be carried out to improve the measurement approaches to the digital economy, i.e., digital economy indices. Based on the results presented in the previous sections, potential future research directions can be identified as follows:

- The digital level and the use of applications for communication with the state. Using survey research, Stofkova et al. (2022) confirmed that people want to be better informed about new e-government services as well as services that are planned to be launched in the future. Therefore, there is a need for research on new applications for communication with the state, i.e., the possibilities and benefits that these applications provide for different age groups. This brings a requirement for further adjustment and improvement of the EGDI index.

- Objectifying weights and indicators included in constructing an individual index of the digital economy (Cruz Jesus et al., 2012). This is especially important to achieve scientifically justified and internationally comparable results of scientific research.

- Creating a global harmonized index of the digital economy. Having in mind the diversity and variety of indicators, authors have highlighted that it is desirable to create a unique composite indicator of digital development and competitiveness that would include various aspects of digitalization (Alam et al., 2018; Stankovic et al., 2022). However, it is difficult to expect this to be achieved in the short term because the prerequisite is the construction and standardization of internationally comparable databases.

- Digitalization and innovation. Digitization facilitates innovation activities and processes (Afonasova et al., 2019; Martínez et al., 2022; Pan et al., 2022; Huiyuan & Xiaomin, 2021; Xu & Li, 2022; Ionescu et al., 2022; Li et al., 2022; Tang et al., 2022). They lead to the accelerated creation of new products and services on the market and the disappearance of old ones. This creates the need for continuous improvement and upgrading of the existing indices of the digital economy. Scholars are also trying to find an answer to the research question of how the digitalization of the economy affects social innovation (Nagy & Somosi, 2022). In this area, there is also significant potential for improving the existing methodological framework.

- Digitalization and environment. In the last few years, the topic of the effect of digitalization on the environment has attracted the most interest among researchers (Firoiu et al., 2022; Han et al., 2022; Wang et al., 2022; Shen et al., 2022; Han et al., 2022; Bai et al., 2022; Li et al., 2022; Liu et al., 2022). Using the entropy value method and spatial Markov chain, Wang et al. (2022) constructed the development index of the digital economy. They applied the spatial Durbin model to analyse the impacts of digitalization on urban carbon emissions in China from 2011 to 2017. The authors created the digital economy index on a sample of data for 265 Chinese cities. The processes of globalization, integration, and technological progress, as well as the need for environmental protection impose the need to construct a unique index of the digital economy that will facilitate the research of the impact of digitization on the environment at the global level.

- Digitization and economic activity. In research on the contribution of digitization to economic activity, digital economy indices are often combined with other methodological approaches or there is often even a combination of several different digital economy indices (Alsaad et al., 2018; Tiutiunyk et al., 2020; Cahyadi & Magda, 2021; Binasova & Daneshjo, 2022; Baranauskas & Raišienė, 2022; Aly, 2022; Aziz et al., 2023). This opens up the space for improving and harmonizing the methodological approaches resulting from combining different methods or indices.
- The contribution of digital economy indices to creating short-term and long-term economic forecasts. Toh Hao et al. (2022) highlighted the significance of digital economy indices in creating economic forecasts. They concluded that digital economy indices make it possible to predict the short-term uncertainties of the economy. They can be useful as a short-term forecasting analytical tool for investors and policymakers to avoid unpredictable risks. Vovk et al. (2021) used the Digital Economy and Society Index (DESI) as a basis for creating forecasts of its main components: connectivity, human capital, use of the internet, integration of digital technology, and digital public services.

5. Conclusions

As a result of rapid technological development, the digital economy is making an increasing contribution to overall economic development (Wang & Chen, 2024). Therefore, there is a need for continuous improvement of the methodological framework for analysing the effects of digital technologies on economic processes and activities. In this context, indices of the digital economy play an increasingly important role. This paper systematically reviews the empirical literature on digital economy indices. The presented results of citation-based analysis show that the greatest contribution to the research area was made by Corrocher and Ordanini (2002) in the paper titled 'Measuring the digital divide: A framework for the analysis of cross-country differences'. In this study, constructing a synthetic index of digitalization, the authors propose a new model for measuring the digital divide within a set of countries or geographical areas.

The publication indexed in the ISI Web of Science database with the largest number of published articles on the researched topic is *Sustainability*. Also, the results obtained indicate a growing interest of scholars in digital economy indices. In addition to an overview of digital economy indices, the content analysis was primarily oriented on methodology development and its application in empirical research. Digital economy indices are continuously developed and upgraded with new methodological proposals (Corrocher & Ordanini, 2002; Wong et al., 2009; Gaaloul & Khalfallah, 2014; Ojanperae et al., 2019; Ferracane & van der Marel, 2020; Popov & Semyachkov, 2020; Goh, 2021; Li et al., 2021; Bai et al., 2022; Luo & Zhou, 2022; Toh Hao et al., 2022; Wang et al., 2022; Chen & Wu, 2022).

Parallel to the methodological development, scholars have tested, combined, compared, and evaluated various digital economy indices in empirical studies (Liu, 2022; Stavytskyy et al., 2019; Rakicevic et al., 2019; Li et al., 2020; Cruz Jesus et al., 2012; Park et al., 2015; Borowiecki et al., 2021; Imran et al., 2022; Karnitis et al., 2019; Skare et al., 2023; Milashovska et al., 2022; Melnychenko et al., 2021; Elmassah & Hassanein, 2022; Volkova et al., 2021; Banhidi & Dobos, 2023; Noja et al., 2022; Moroz, 2017; Wang et al., 2022; Wu et al., 2023; Shen & Zhang, 2022; Han et al., 2022; Lomakina et al., 2021; Marshall et al., 2020; Marino & Pariso, 2021; Szabolcs et al., 2022; Wang & Shi, 2021; Huang et al., 2022; Lyu et al., 2023; Chen et al., 2022; Chen & Wu, 2022).

The usefulness of digital economy indices is confirmed by their application in empirical studies. Research articles cover a wide range of topics, including the digitalization of public services, the digital divide across countries, the comparison of digital transformation in the European Union, the effects of digitalization on economic growth, the testing of digital financial inclusion, digitalization, and competitiveness, and the impact of the digital economy on innovation (Todoruț et al., 2018; Verkijika & De Wet, 2018; Surjit & Das, 2020; Fernández-Portillo et al., 2020; Ullah et al., 2021; Borowiecki et al., 2021; Vyshnevskyi et al., 2021; Liu, 2022; Soava et al., 2022; Olczyk et al., 2022; He et al., 2022; Zhou et al., 2022; Shen et al., 2022; Hurduzeu et al., 2022; Xu & Li, 2022).

Special attention of researchers in the last few years has been focused on the development of digital economy indices in areas where the role of digital technologies in the development of the green economy and environmental economy is tested (Bai et al., 2022; Li et al., 2022; Wang et al., 2022; Lyu et al., 2023).

The outcomes presented in this study offer insight into former research on digital economy indices in terms of methodological development and empirical findings. The final result of this review process is an advancement of the knowledge base for scholars and practitioners.

The limitation of this study stems from the fact that the research sample comprises only articles indexed in the Web of Science database. An additional limitation could arise from the fact that the collected research sample focuses exclusively on studies available on the internet. These limitations are somewhat mitigated by digitization processes being relatively recent and having a relatively short history.

It is valuable to emphasize both the research's theoretical and practical implications. Digitization is of great importance for improving and strengthening activities in all economic sectors. Numerous scientific studies have confirmed the positive contributions of digitization to economic growth, innovation, the efficiency of public administration, economic cooperation among countries, environmental protection, and energy efficiency. This study provides a complete picture of digital economy indices. From a methodological point of view, it covers the basic methodological features of digital economy indices, as well as the latest methodological proposals. The presented advantages and limitations of individual indices facilitate the selection and application of adequate indices in upcoming studies. The results presented in this research can indicate insufficiently explored topics, and thus, stimulate the creation of new research ideas. One of the biggest challenges for scholars in future research is how to construct and apply a harmonized index of the digital economy. Considering the different areas of application of digital economy indices, new methodological proposals can be expected about a unique index that could facilitate the research of the impact of digitization on the environment and energy efficiency.

In conditions of external influences and shocks such as trade restrictions and the migrant crisis, digitalization gains additional significance. In such circumstances, research endeavours aimed at developing a methodological framework such as digital economy indices gain even greater importance, not only in terms of the realization of new scientific contributions but also of broad theoretical and practical implications.

References

Abideen, A. Z., Binti Mohamad, F., & Fernando, Y. (2021). Lean simulations in production and operations management–a systematic literature review and bibliometric analysis. *Journal of Modelling in Management*, 16 (2), 623-650. https://doi.org/10.1108/JM2-05-2019-0103

Afonasova, M. A., Panfilova, E. E., Galichkina, M. A., & Slusarczyk, B. (2019). Digitalization in Economy and Innovation: The Effect on Social and Economic Processes. *Polish Journal of Management Studies*, 19 (2), 22-32. DOI: 10.17512/pjms.2019.19.2.02

Alam, K., Erdiaw-Kwasie, M. O., Shahiduzzaman, M., & Ryan, B. (2018). Assessing regional digital competence: Digital futures and strategic planning implications. *Journal of rural studies*, 60, 60-69. https://doi.org/10.1016/j.jrurstud.2018.02.009

Ali, T. M., Bashir, T., & Kausar Kiani, A. (2015). Assessment of technological capabilities of OIC countries. *Science, Technology and Society*, 20 (1), 114-131. https://doi.org/10.1177/0971721814561394

Alibekova, G., Medeni, T., Panzabekova, A., & Mussayeva, D. (2020). Digital Transformation Enablers and Barriers in the Economy of Kazakhstan. *Journal of Asian Finance, Economics and Business*, 7 (7), 565 – 575. https://doi.org/10.13106/jafeb.2020.vol7.no7.565

Alsaad, A., Mohamad, R., Taamneh, A., & Ismail, N. A. (2018). What drives global B2B e-commerce usage: an analysis of the effect of the complexity of trading system and competition pressure. *Technology Analysis & Strategic Management*, (30) 8, 980-992. https://doi.org/10.1080/09537325.2018.1432853

Aly, H. (2022). Digital transformation, development and productivity in developing countries: is artificial intelligence a curse or a blessing? *Review of Economics and Political Science*, 7 (4), 238-256. https://doi.org/10.1108/REPS-11-2019-0145

Aniscenko, Z., Robalino-López, A., Escobar Rodríguez, T., & Escobar Pérez, B. (2017). Regional E-Government development: evolution of EGDI in Andean countries. In *2017 Fourth International Conference on eDemocracy & eGovernment (ICEDEG)*, pp. 22-31. IEEE, 2017. DOI: 10.1109/ICEDEG.2017.7962509

Anton, S. G., & Nucu, A. E. A. (2020). Enterprise Risk Management: A Literature Review and Agenda for Future Research. *Journal of Risk and Financial Management*, 13, Article 281. https://doi.org/10.3390/jrfm13110281

Archibugi, D. & Coco, A. (2004). A New Indicator of Technological Capabilities for Developed and Developing Countries (ArCo). *World Development*, 32 (4), 629-654. https://doi.org/10.1016/j.worlddev.2003.10.008

Atici, B. (2010). Information society statistics and indicators: The case of Turkey. *African Journal of Business Management*, 4 (7), 1363-1371.

Aziz, T., Uddin Khan, Md. G., Islam, Md. T., & Hannan Pradhan, M. A. (2023). An analysis on the relationship between ICT, financial development and economic growth: Evidence from Asian developing countries. *The Journal of International Trade & Economic Development*, 32 (5), 705-721. https://doi.org/10.1080/09638199.2022.2134912

Bai, F., Huang, Y., Shang, M., & Ahmad, M. (2022). Modeling the impact of digital economy on urban environmental pollution: Empirical evidence from 277 prefecture-level cities in China. *Frontiers in Environmental Science*, 10 (1), Article 991022. https://doi.org/10.3389/fenvs.2022.991022

Banhidi, Z., & Dobos, I. (2023). Measurement of digital development with partial orders, Tiered DEA, and cluster analysis for the European Union. *International Review of Applied Sciences and Engineering*, 14 (3), 392-401. https://doi.org/10.1556/1848.2023.00612

Banhidi, Z., Dobos, I., & Nemeslaki, A. (2020). What the overall Digital Economy and Society Index reveals: A statistical analysis of the DESI EU28 dimensions. *Regional Statistics*, 10 (2), 42-62. DOI: 10.15196/RS100209

Baranauskas, G., & Raišienė, A. G. (2022). Transition to Digital Entrepreneurship with a Quest of Sustainability: Development of a New Conceptual Framework. *Sustainability*, 14 (3), 1104. https://doi.org/10.3390/su14031104

Basol, O., & Yalçin, 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. DOI: 10.3233/HSM-200904

Bedford, D. A. D. (2013). Expanding the Definition and Measurement of Knowledge Economy: Integrating Triple Bottom Line Factors into Knowledge Economy Index Models and Methodologies. *Journal of modern accounting and auditing*, 9, 278-286.

Bilal, J. T. (2017). Ensuring Transparency and Access to Information in the Management of Public Institutions Through E-Government. *Proceedings of the International Management Conference*, Faculty of Management, Academy of Economic Studies, Bucharest, Romania. 11 (1), 88-98.

Binasova, V. & Daneshjo, N. (2022). Digital Skills as a Significant Factor of Human Resources Development. *Sustainability*, 14 (20), 13117. https://doi.org/10.3390/su142013117

Borowiecki, R., Siuta-Tokarska, B., Maron, J., Suder, M.; Thier, A., & Zmija, K. (2021). Developing Digital Economy and Society in the Light of the Issue of Digital Convergence of the Markets in the European Union Countries. *Energies*, 14 (9), 2717. https://doi.org/10.3390/en14092717

Burinskienė, A., & Pipirienė, V. (2014). Technological innovations and technology achievement. In: *The 8th International Scientific Conference "Business and Management 2014",* 15–16 May 2014, Vilnius, Lithuania.

Buturac, G. (2022). Measurement of Economic Forecast Accuracy: A Systematic Overview of the Empirical Literature. *Journal of Risk and Financial Management*, 15 (1), 1. https://doi.org/10.3390/jrfm15010001

Cahyadi, A., & Magda, R. (2021). Digital Leadership in the Economies of the G20 Countries: A Secondary Research. *Economies*, 9 (1), 32. https://doi.org/10.3390/economies9010032

Chen, S., & Zhang, H. (2021). Does digital finance promote manufacturing servitization: Micro evidence from China. *International Review of Economics & Finance*, 76, 856-869. https://doi.org/10.1016/j.iref.2021.07.018

Chen, W., Wang, Q., & Zhou, H. (2022). Digital Rural Construction and Farmers' Income Growth: Theoretical Mechanism and Micro Experience Based on Data from China. *Sustainability*, 14 (18), 11679. https://doi.org/10.3390/su141811679

Chen, W., & Wu, Y. (2022). Does intellectual property protection stimulate digital economy development? *Journal of Applied Economics*, 25 (1), 723-730. https://doi.org/10.1080/15140326.2022.2045846

Chen, X., Yan, D., & Chen, W. (2022). Can the digital economy promote FinTech development? *Growth and Change*, 53 (1), 221-247. https://doi.org/10.1111/grow.12582

Chen, Y., Xu, S., Lyulyov, O., & Pimonenko, T. (2022). China's Digital Economy Development: Incentives and Challenges. *Technological and Economic Development of Economy*, 1-21. (Article in press). https://doi.org/10.3846/tede.2022.18018

Cherchye, L., Moesen, W., Rogge, N., Van Puyenbroeck, T., Saisana, M., Saltelli, A., Liska, R., & Tarantola, S. (2008). Creating composite indicators with DEA and robustness analysis: the case of the

Technology Achievement Index. *Journal of the Operational Research Society*, 59 (2), 239-251. https://doi.org/10.1057/palgrave.jors.2602445

Corrocher, N., & Ordanini, A. (2002). Measuring the digital divide: A framework for the analysis of cross-country differences. *Journal of Information technology*, 17 (1), 9-19.

Cruz Jesus, F., Oliveira, T., & Bação, F. (2012). Digital Divide across the European Union. *Information & Management*. 49 (6), 278-291. https://doi.org/10.1016/j.im.2012.09.003

Desai, M., Fukuda-Parr, S., Johansson C., & Sagasti F., (2002). Measuring the Technology Achievement of Nations and the Capacity to Participate in the Network Age. *Journal of Human Development*, 3 (1), 96-122.

Dobrolyubova, E. (2021). Measuring outcomes of digital transformation in public administration: Literature review and possible steps forward. *NISPAcee Journal of Public Administration and Policy*, 14 (1), 61-86. https://doi.org/10.2478/nispa-2021-0003

Elmassah, S., & Hassanein, E. A. (2022). Digitalization and subjective wellbeing in Europe. *Digital Policy Regulation and Governance*, 24 (1), 52-73. https://doi.org/10.1108/DPRG-05-2021-0060

Emrouznejad, A., Cabanda, E., & Gholami, R. (2010). An alternative measure of the ICT-Opportunity Index. *Information & Management*, 47 (4), 246-254. https://doi.org/10.1016/j.im.2010.04.002

Ershova, I., Obukhova, A., & Belyaeva, O. (2021). Implementation of innovative digital technologies in the world. *Economic Annals-XXI*, 186 (11-12), 28-35. https://doi.org/10.21003/ea.V186-04

Esses, D., Csete, M. S., & Németh, B. (2021). Sustainability and Digital Transformation in the Visegrad Group of Central European Countries. *Sustainability*, 13 (11), 5833. https://doi.org/10.3390/su13115833

European Commission (2022). Digital Economy and Society Index 2022 - Methodological Note. European Commission: Brussels.

Fathey, M., & Othman, I. (2013). Refining E-government Readiness Index by Cloud Computing. *Jurnal Teknologi*, 65 (1), 23-34. https://doi.org/10.11113/jt.v65.1759

Fernández-Portillo, A., Almodóvar-González, M., & Hernández-Mogollón, R. (2020). Impact of ICT development on economic growth. A study of OECD European union countries. *Technology in Society*, 63, 101420. https://doi.org/10.1016/j.techsoc.2020.101420

Ferracane, M. F., & van der Marel, E. (2020). Patterns of trade restrictiveness in online platforms: A first look. *The World Economy*, 43 (11), 2932-2959. https://doi.org/10.1111/twec.13030

Firoiu, D., Pîrvu, R., Jianu, E., Cismaș, L. M., Tudor, S., & Lățea, G. (2022). Digital Performance in EU Member States in the Context of the Transition to a Climate Neutral Economy. *Sustainability*, 14 (6), 3343. https://doi.org/10.3390/su14063343

Gaaloul, H., & Khalfallah, S. (2014). Application of the 'Benefit-Of-the-Doubt' Approach for the Construction of a Digital Access Indicator: A Revaluation of the 'Digital Access Index'. *Social Indicators Research*, 118 (1), 45–56. http://www.jstor.org/stable/24720990

Goh, A. (2021). Digital Readiness Index for Arbitration Institutions: Challenges and Implications for Dispute Resolution Under the Belt and Road Initiative. *Journal of International Arbitration*, 38 (2), 253-290. https://doi.org/10.54648/joia2021013

Grilli, L., Latifi, G., & Mrkajic, B. (2019). Institutional determinants of venture capital activity. *Journal of Economic Surveys*, 33, 1094–122. https://doi.org/10.1111/joes.12319

Grinberga-Zalite, G., & Hernik, J. (2019). Digital performance indicators in the EU. *Research for Rural Development*, 2, 183-188. DOI: 10.22616/rrd.25.2019.067

Guo, F., Wang, J. Y., Wang, F., Kong, T., Zhang, X., & Cheng, Z. Y. (2020). Measuring China's development of digital financial inclusion: index construction and space characteristics. *China Economic Quarterly (in Chinese)*, 19 (4): 1401-1418.

Guo, J., Zhang, K., & Liu, K. (2022). Exploring the Mechanism of the Impact of Green Finance and Digital Economy on China's Green Total Factor Productivity. *International Journal of Environmental Research and Public Health*, 19 (23), Article 16303. https://doi.org/10.3390/ijerph192316303

Haider, S. A., Zeeshan, M., Irshad, M., Noman, S. M., Arshad, J., Ahmed S., Pervaiz, A., & Naseer, F. (2021). The inclusive analysis of ICT ethical issues on healthy society: A global digital divide approach. *Procedia Computer Science*, 183, 801-806. https://doi.org/10.1016/j.procs.2021.03.001

Han, D., Ding, Y., Shi, Z., & He, Y. (2022). The impact of digital economy on total factor carbon productivity: the threshold effect of technology accumulation. *Environmental Science and Pollution Research*, 29 (37), 55691-55706. DOI: 10.1007/s11356-022-19721-x

Hanafizadeh, M. R., Saghaei, A., & Hanafizadeh, P. (2009). An index for cross-country analysis of ICT infrastructure and access. *Telecommunications Policy*, 33 (7), 385-405. https://doi.org/10.1016/j.telpol.2009.03.008

He, Z., Chen, H., Hu, J., & Zhang, Y. (2022). The impact of digital inclusive finance on provincial green development efficiency: empirical evidence from China. *Environmental Science and Pollution Research*, 29 (60), 90404-90418. https://doi.org/10.1007/s11356-022-22071-3

Huang, J. Y., Shieh, J. C. P., & Kao, Y.-C. (2016). Starting points for a new researcher in behavioral finance. *International Journal of Managerial Finance*, 12 (1): 92-103. https://doi.org/10.1108/IJMF-05-2015-0111

Huang, X., Zhou, J., & Zhou, Y. (2022). Digital Economy's Spatial Implications on Urban Innovation and Its Threshold: Evidence from China. *Complexity*, Article 3436741. https://doi.org/10.1155/2022/3436741

Huiyuan, H., & Xiaomin, G. (2021). Linkage Between Inclusive Digital Finance and High-Tech Enterprise Innovation Performance: Role of Debt and Equity Financing. *Frontiers Psychology*, 12, Article 814408. https://doi.org/10.3389/fpsyg.2021.814408

Hurduzeu, G., Lupu, I., Lupu, R., & Ion Filip, R. (2022). The Interplay between Digitalization and Competitiveness: Evidence from European Countries. *Societies*, 12 (6), 157. https://doi.org/10.3390/soc12060157

Imran, M., Liu, X., Wang, R., Saud, S., Zhao, Y., 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 11130. https://doi.org/10.3390/su141811130

Incekara, A., Guz, T., & Sengun, G. (2017). Measuring the technology achievement index: comparison and ranking of countries. *Journal of Economics, Finance and Accounting*, 4 (2), 164-174. http://doi.org/10.17261/Pressacademia.2017.446

Ionescu, A. M., Clipa, A.-M., Turnea, E.-S., Clipa, C.-I., Bedrule-Grigoruta, M. V., & 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. https://doi.org/10.3846/jbem.2022.17039

Ivanović-Đukić, M., Stevanović, T., & Rađenović, T. (2019). Does digitalization affect the contribution of entrepreneurship to economic growth. In *Proceedings of Rijeka Faculty of Economics: Journal of Economics and Business*, 36 (2), 653-679. https://doi.org/10.18045/zbefri.2019.2.653

James, J. (2007). Cumulative Bias in the New Digital Opportunity Index: Sources and Consequences. *Current Science*, 92 (1), 46–50. http://www.jstor.org/stable/24096820

James, J. (2008). Digital preparedness versus the digital divide: A confusion of means and ends. *Journal of the American Society for Information Science and Technology*, 59 (5), 785-791. https://doi.org/10.1002/asi.20793

Janowski, T. (2015). Digital government evolution: From transformation to contextualization. *Government Information Quarterly*, 32 (3), 221-236. https://doi.org/10.1016/j.giq.2015.07.001

Jovanović, M., Dlačić, J., & Okanović, M. (2018). Digitalization and society's sustainable development–Measures and implications. *Zbornik radova Ekonomskog fakulteta u Rijeci: časopis za ekonomsku teoriju i praksu*, 36 (2), 905-928. https://doi.org/10.18045/zbefri.2018.2.905

Jovanovic Milenkovic, M., Brajovic, B., Milenkovic, D., Vukmirovic, D., & Jeremic, V. (2016). Beyond the equal-weight framework of the Networked Readiness Index: a multilevel I-distance methodology. *Information Development*, 32(4), 1120–1136. https://doi.org/10.1177/0266666915593136

Jurcevic, M., Lulic, L., & Mostarac, V. (2020). The Digital Transformation of Croatian Economy Compared with EU Member Countries. *Ekonomski vjesnik*, 13 (1), 151-164.

Kabbar, E., & Dell, P. (2013). Weaknesses of the E-Government Development Index. In: Uesugi, S. (eds) IT Enabled Services. Springer, Vienna. https://doi.org/10.1007/978-3-7091-1425-4_7

Kallal, R., Abir H., & Ftiti, Z. (2021). ICT diffusion and economic growth: Evidence from the sectorial analysis of a periphery country. *Technological Forecasting and Social Change*, 162 (2021), Article 120403. https://doi.org/10.1016/j.techfore.2020.120403

Karnitis, G., Virtmanis, A., & Karnitis, E. (2019). Key drivers of digitalization; EU context and Baltic case. *Baltic journal of modern computing*, 7 (1), 70-85. https://doi.org/10.22364/bjmc.2019.7.1.06

Kelly, T., & Biggs, P. (2007). The digital opportunity index. *Current Science*, 92 (10), Article 1327.

Kirkman, S. G., Osorio, C. A., & Sachs, J. D. (2002). The Networked Readiness Index: Measuring the Preparedness of Nations for the Networked World. In Kirkman (ed.) *The Global Information Technology Report 2001-2002. Readiness for the networked world*. New York, Oxford University Press, pp. 10–29.

Kononova, K. (2015). Some Aspects of ICT Measurement: Comparative Analysis of E-Indexes. *Proceedings of the 7th International Conference on Information and Communication Technologies in Agriculture, Food and Environment*. Zacharoula Andreopoulou and Dionysis Bochtis: Editors. Kavala, Greece, September 17-20, 2015. pp. 938-945.

Kotarba, M. (2017). Measuring Digitalization - Key Metrics. *Foundations of Management*, 9 (1), 123-138. https://doi.org/10.1515/fman-2017-0010

Kovács, T. Z., Bittner, B., Huzsvai, L., & Nábrádi, A. (2022). Convergence and the Matthew Effect in the European Union Based on the DESI Index. *Mathematics*, 10 (4), Article 613. https://doi.org/10.3390/math10040613

Kwilinski, A., Vyshnevskyi, O., & Dzwigol, H. (2020). Digitalization of the EU Economies and People at Risk of Poverty or Social Exclusion. *Journal of Risk and Financial Management*, 13 (7), Article 142. https://doi.org/10.3390/jrfm13070142

Laitsou, E., Kargas, A., & Varoutas, D. (2020). Digital Competitiveness in the European Union Era: The Greek Case. *Economies*, 8 (4), Article 85. https://doi.org/10.3390/economies8040085

Li, H., Zhuge, R., Han, J., Zhao, P., & Gong, M. (2022). Research on the impact of digital inclusive finance on rural human capital accumulation: A cross-sectional study of the Chinese region. *Frontiers in Environmental Science*, 10, Article 1225. https://doi.org/10.3389/fenvs.2022.936648

Li, J., Chen, L., Chen, Y., & He, J. (2022). Digital economy, technological innovation, and green economic efficiency-Empirical evidence from 277 cities in China. *Managerial and Decision Economics*, 43 (3), 616-629. https://doi.org/10.1002/mde.3406

Li, K., Kim, D. J., Lang, K. R., Kauffman, R. J., & Naldi, M. (2020). How should we understand the digital economy in Asia? Critical assessment and research agenda. *Electronic Commerce Research and Applications*, 44 (1): Article 101004. https://doi.org/10.1016/j.elerap.2020.101004

Li, Z., Li, N. & Wen, H. (2021). Digital Economy and Environmental Quality: Evidence from 217 Cities in China. *Sustainability,* 13 (14): Article 8058. https://doi.org/10.3390/su13148058

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. https://doi.org/10.1002/poi3.274

Liu, Y., Yang, Y., Li, H., & Zhong, K. (2022). Digital economy development, industrial structure upgrading and green total factor productivity: Empirical evidence from China's cities. *International Journal of Environmental Research and Public Health*, 19 (4), Article 2414. https://doi.org/10.3390/ijerph19042414

Lomakina, O., Kookueva, V., & Makarenko, A. (2021). Redistribution of economic resources in the digital society. *Business and Society Review,* 126 (1), 25-35. https://doi.org/10.1111/basr.12220

López Peláez, A., Erro-Garcés, A., & Gómez-Ciriano, E. J. (2020). Young people, social workers and social work education: The role of digital skills. *Social Work Education*, 39 (6), 825-842. https://doi.org/10.1080/02615479.2020.1795110

Luo, R., & Zhou, N. (2022). Dynamic Evolution, Spatial Differences, and Driving Factors of China's Provincial Digital Economy. *Sustainability*, 14 (15), Article 9376. https://doi.org/10.3390/su14159376

Lyu, K., Yang, S., Zheng, K., & Zhang, Y. (2023). How Does the Digital Economy Affect Carbon Emission Efficiency? Evidence from Energy Consumption and Industrial Value Chain. *Energies*, 16 (2), Article 761. https://doi.org/10.3390/en16020761

Marino, A., & Pariso, P. (2021). Digital Economy: Technological, Organizational and Cultural Contexts for the Development of Cooperation in Europe. *Entrepreneurship and Sustainability Issues*, 9 (2), 363-383. http://doi.org/10.9770/jesi.2021.9.2(24)

Márquez-Ramos, L., & Martínez-Zarzoso, I. (2010). The effect of technological innovation on international trade. *Economics,* 4 (1), 1-37.

Marshall, A., Dezuanni, M., Burgess, J., Thomas, J., & Wilson, C. K. (2020). Australian farmers left behind in the digital economy – Insights from the Australian Digital Inclusion Index. *Journal of Rural Studies*, 80, 195-210. https://doi.org/10.1016/j.jrurstud.2020.09.001

Martínez, J. M. G., Puertas, R., Martín, J. M. M., & Ribeiro-Soriano, D. (2022). Digitalization, innovation and environmental policies aimed at achieving sustainable production. *Sustainable Production and Consumption*, 32 (2022), 92-100. https://doi.org/10.1016/j.spc.2022.03.035

Melnychenko, S., Tkachenko, T., & Dupliak, T. (2021). Digitalisation as a tool of tourism recovery in European Union in post-COVID-19. *Financial and Credit Activity: Problems of Theory and Practice*, 6, (41), 427-436. https://doi.org/10.18371/fcaptp.v6i41.251471

Milashovska, O., Liba, N., Korolovych, O., Smyrnova, N., & Slatvinska, V. (2022). The potential of applying blockchain technologies in various sectors of the digital economy. *Revista De La Universidad Del Zulia*, 13 (36), 288-304. http://dx.doi.org/10.46925//rdluz.36.19

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. https://doi.org/10.1515/fman-2017-0014

Nagy, S., & Somosi, M. V. (2022). The relationship between social innovation and digital economy and society. *Regional Statistics*, 12 (2), 3-29. DOI: 10.15196/RS120202

Nasir, A., Ali, T. M., Shahdin, S., & Rahman, T. (2011). Technology achievement index 2009: ranking and comparative study of nations. *Scientometrics*, 87 (1), 41-62. https://doi.org/10.1007/s11192-010-0285-6

Nauriyal, D. K., & Bhalla, S. (2006). Global telecom revolution: Spatial-Temporal aspects. *Journal of Scientific & Industrial Research*, 65 (3), 195-212.

Noja, G. G., Cristea, M., Panait, M., Trif, S. M., & Ponea, C. S. (2022). The Impact of Energy Innovations and Environmental Performance on the Sustainable Development of the EU Countries in a Globalized Digital Economy. *Frontiers in Environmental Science*, 10, Article 934404. https://doi.org/10.3389/fenvs.2022.934404

Ogrean, C., & Herciu, M. (2022). Exploring Romania's Digital Gap - What is Under the Water, If this is Only the Tip of the Iceberg? *Studies in Business and Economics*, 17 (1), 312 – 322. https://doi.org/10.2478/sbe-2022-0020

Ojanperae, S., Graham, M., & Zook, M. (2019). The Digital Knowledge Economy Index: Mapping Content Production. *Journal of Development Studies*, 55 (12), 2626-2643. https://doi.org/10.1080/00220388.2018.1554208

Olczyk, M., & Kuc-Czarnecka, M. (2022). Digital transformation and economic growth – DESI improvement and implementation. *Technological and Economic Development of Economy*, 28 (3), 775–803. https://doi.org/10.3846/tede.2022.16766

Osman, I. H., & Zablith, F. (2021). Re-evaluating electronic government development index to monitor the transformation toward achieving sustainable development goals. *Journal of Business Research*, 131 (2021), 426-440. https://doi.org/10.1016/j.jbusres.2020.10.027

Pan, W., Xie, T., Wang, Z., & Ma, L. (2022). Digital economy: An innovation driver for total factor productivity. *Journal of Business Research*, 139 (1), 303-311. https://doi.org/10.1016/j.jbusres.2021.09.061

Park, S. R., Choi, D. Y., & Hong, P. (2015). Club convergence and factors of digital divide across countries. *Technological Forecasting and Social Change*, 96, 92-100. https://doi.org/10.1016/j.techfore.2015.02.011

Petkova, L., Ryabokon, M., & Vdovychenko, Y. (2019). Modern systems for assessing the informatization of countries in the context of global sustainable development. *Baltic Journal of Economic Studies*, 5 (2), 158-170. https://doi.org/10.30525/2256-0742/2019-5-2-158-170

Petrenko, S., Makoveichuk, K. A., Chetyrbok, P. V., & Petrenko, A. S. (2017). About Readiness for Digital Economy. In *2nd IEEE International Conference on Control in Technical Systems (CTS)*. St Petersburg, Russia. pp. 96-99.

Popov, E., & Semyachkov, K. (2020). Smart Cities Development Indices. In E. Popov, V. Barkhatov, V. D. Pham, and D. Pletnev (Eds.), *Competitiveness and the Development of Socio-Economic Systems*, vol 105. *European Proceedings of Social and Behavioural Sciences* (pp. 4-9). European Publisher. https://doi.org/10.15405/epsbs.2021.04.2

Prasad, P., Narayanasamy, S., Paul, S., Chattopadhyay, S., & Saravanan, P. (2018). Review of literature on working capital management and future research agenda. *Journal of Economic Surveys*, 33, 827–61. https://doi.org/10.1111/joes.12299

Rakicevic, J., Rakicevic, A., & Poledica, A. (2019). Logical clustering approach for analysing digital economy and society performance of countries. *Proceedings of the 11th Conference of the European Society for Fuzzy Logic and Technology (EUSFLAT 2019)*. Edited by: Novak, V.; Marik, V.; Stepnicka, M.; Navara, M.; Hurtik, P.; Czech Tech Univ, Prague, Czech Republic. September 09-13, 2019. pp. 550-557.

Rao, S., Pan, Y., He, J., & Shangguan, X. (2022). Digital finance and corporate green innovation: quantity or quality? *Environmental Science and Pollution Research,* 29 (37), 56772-56791. https://doi.org/10.1007/s11356-022-19785-9

Rath, B. N. (2016). Does the digital divide across countries lead to convergence? New international evidence. *Economic Modelling*, 58, 75-82. https://doi.org/10.1016/j.econmod.2016.05.020

Samoilenko, S., & Osei-Bryson, K. M. (2019). Representation matters: An exploration of the socio-economic impacts of ICT-enabled public value in the context of sub-Saharan economies. *International Journal of Information Management*, 49, 69-85. https://doi.org/10.1016/j.ijinfomgt.2019.03.006

Shen, X., Zhao, H., Yu, J., Wan, Z., He, T., & Liu, J. (2022). Digital economy and ecological performance: Evidence from a spatial panel data in China. *Frontiers in Environmental Science*, 10 (1), Article 969878. https://doi.org/10.3389/fenvs.2022.969878

Shen, Y., & Zhang, X. (2022). Digital Economy, Intelligent Manufacturing, and Labor Mismatch. *Journal of Advanced Computational Intelligence and Intelligent Informatics*, 26 (4), 655-664. https://doi.org/10.20965/jaciii.2022.p0655

Sivarajah, U., Irani, Z., & Weerakkody, V. (2015). Evaluating the use and impact of Web 2.0 technologies in local government. *Government Information Quarterly*, 32 (4), 473-487. https://doi.org/10.1016/j.giq.2015.06.004

Skare, M., de Obesso, M. 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 (1), Article 102594. https://doi.org/10.1016/j.ijinfomgt.2022.102594

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, 104, 333–39. https://doi.org/10.1016/j.jbusres.2019.07.039

Soava, G., Mehedintu, A., & Sterpu, M. (2022). Analysis and Forecast of the Use of E-Commerce in Enterprises of the European Union States. *Sustainability*, 14 (14), Article 8943. https://doi.org/10.3390/su14148943

Solomon, E. M., & van Klyton, A. (2020). The impact of digital technology usage on economic growth in Africa. *Utilities policy*, 67, Article 101104. https://doi.org/10.1016/j.jup.2020.101104

Spivakovskyy, S., Kochubei, O., Shebanina, O., Sokhatska, O., Yaroshenko, I., & Nych, T. (2021). The Impact of Digital Transformation on the Economic Security of Ukraine. *Estudios de Economia Aplicada*, 39 (5), 1-10. https://doi.org/10.25115/eea.v39i5.5040

Stanković, J. J., Marjanović, I., Drezgić, S., & Popovic, Ž. (2021). The Digital Competitiveness of European Countries: A Multiple-Criteria Approach. *Journal of Competitiveness*, 13 (2), 117–134. https://doi.org/10.7441/joc.2021.02.07

Stavytskyy, A., Kharlamova, G., Stoica, E. A. (2019). The Analysis of the Digital Economy and Society Index in the EU. *Baltic Journal of European Studies*, 9 (3), 245-261. https://doi.org/10.1515/bjes-2019-0032

Stofkova, J., Poliakova, A., Stofkova, K.R., Malega, P., Krejnus, M., Binasova, V., & Daneshjo, N. (2022). Digital Skills as a Significant Factor of Human Resources Development. *Sustainability*, 14 (20), Article 13117. https://doi.org/10.3390/su142013117

Subrahmanya, M. H. B. (2005). Pattern of technological innovations in small enterprises: A comparative perspective of Bangalore (India) and Northeast England (UK). *Technovation*, 25 (3), 269-280. https://doi.org/10.1016/S0166-4972(03)00094-4

Sukhodolov P. A., & Popkova G. E. (2018). Information Economy in Asian Countries. *Sukhodolov,*

A.P., Popkova, E.G. and Litvinova, T.N. (Ed.) Models of Modern Information Economy, Emerald Publishing Limited, Bingley, pp. 47-56. https://doi.org/10.1108/978-1-78756-287-520181006

Surjit, P., & Das, S. (2020). Accessibility and usability analysis of Indian e-government websites. *Universal Access in the Information Society*, 19 (4), 949-957. https://doi.org/10.1007/s10209-019-00704-8

Szabó, Z. K., & Chiriac, L. (2016). Investigations Concerning E-Government Adoption in Transition Economies. *Acta Oeconomica*, 66 (1), 57-78. https://doi.org/10.1556/032.2016.66.1.3

Tang, G. N., Ren, F., & Zhou, J. (2022). Does the digital economy promote "innovation and entrepreneurship" in rural tourism in China? *Frontiers in Psychology*, 13 (1), Article 979027. https://doi.org/10.3389/fpsyg.2022.979027

Tiutiunyk, I., Zolkover, A., Maslov, V., Vynnychenko, N., Samedova, M., Beshley, Y., & Kovalenko, O. (2020). Indices of innovation activity as components of macroeconomic stability: how does the shadowing of investment flows affect? *Marketing and Management of Innovations*, 4, 26-40. https://doi.org/10.21272/mmi.2020.4-02

Todoruţ, A. V., & Tselentis, V. (2018). Digital technologies and the modernization of public administration. *Calitatea-Acces la Success*, 19 (165), 73-78.

Toh Hao, T., Kueh, J., & Wong Siew Ling, S. (2022). Constructing digital economy index: Case of small open economy. *International Journal of Nonlinear Analysis and Applications*, 13 (2), 69-82. DOI: 10.22075/ijnaa.2021.23800.2612

Topornin, N., Pyatkina, D., & Bokov, Y. (2021). Government regulation of the Internet as instrument of digital protectionism in case of developing countries. *Journal of Information Science*, 49 (39), 1-14. https://doi.org/10.1177/01655515211014142

Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British journal of management*, 14 (3), 207-222. https://doi.org/10.1111/1467-8551.00375

Ullah, A., Pinglu, C., Ullah, S., Abbas, H. S. M., & Khan, S. (2021). The Role of E-Governance in Combating COVID-19 and Promoting Sustainable Development: A Comparative Study of China and Pakistan. *Chinese Political Science Review*, 6 (1), 86–118. https://doi.org/10.1007/s41111-020-00167-w

Vehovar, V., Sicherl, P., Hüsing, T., & Dolnicar, V. (2006). Methodological challenges of digital divide measurements. *The information society*, 22 (5), 279-290.

Verkijika, S. F., & De Wet, L. (2018). A usability assessment of e-government websites in Sub-Saharan Africa. *International Journal of Information Management*, 39, 20-29. https://doi.org/10.1016/j.ijinfomgt.2017.11.003

Vidruska, R. (2016). The Digital Economy & Society Index and Network Readiness Index: Performance of Latvia on European Union Arena. In *New Challenges of Economic and Business Development—2016*. Riga: University of Latvia.

Volkova, N., Kuzmuk, I., Oliinyk, N., Klymenko, I., & Dankanych, A. (2021). Development Trends of the Digital Economy: E-Business, E-Commerce. International Journal of Computer Science & Network Security, 21 (4), 186-198. https://doi.org/10.22937/IJCSNS.2021.21.4.23

Vovk, V., Denysova, A., Rudoi, K., & Kyrychenko, T. (2021). Management and legal aspects of the symbiosis of banking institutions and fintech companies in the credit services market in the context of digitization. *Estudios de economía aplicada*, 39 (7), 1-14. https://doi.org/10.25115/eea.v39i7.5013

Vyshnevskyi, O., Stashkevych, I., Shubna, O., & Barkova, S. (2021). Economic Growth in the Conditions of Digitalization in the EU Countries. *Studies of Applied Economics*, 38 (4), 1-9. https://doi.org/10.25115/eea.v38i4.4041

Vysochyna, A., Semenov, V., & Kyrychenko, K. (2021). Marketing and Management of Innovations in Public Governance as Core Determinants of Trust. *Marketing and Management of Innovations*, 2 (2021), 204-212. http://doi.org/10.21272/mmi.2021.2-17

Wang, Z. (2022). Digital Finance, Financing Constraint and Enterprise Financial Risk. *Journal of Mathematics*, 2022, Article 2882113. https://doi.org/10.1155/2022/2882113

Wang, J., Dong, K., Dong, X., & Taghizadeh-Hesary, F. (2022). Assessing the digital economy and its carbon-mitigation effects: The case of China. *Energy Economics*, 113, Article 106198. https://doi.org/10.1016/j.eneco.2022.106198

Wang, J., Wang, K., Dong, K., & Shahbaz, M. (2022). How does the digital economy accelerate global energy justice? Mechanism discussion and empirical test. *Energy Economics*, 114 (1), Article 106315. https://doi.org/10.1016/j.eneco.2022.106315

Wang, P., Han, W., Rizvi, S.K.A., & Naqvi, B. (2022). Is Digital Adoption the way forward to Curb Energy Poverty?. *Technological Forecasting and Social Change*, 180, Article 121722. https://doi.org/10.1016/j.techfore.2022.121722

Wang, X., & Chen, J. (2024). An empirical study on the indirect empowerment of economic development by the digital economy-based on the perspective of China's domestic economic cycle. *Journal of the Knowledge Economy*, 15(2), 9393-9419. https://doi.org/10.1007/s13132-023-01445-z

Wang, X., Sun, X., Zhang, H., & Ahmad, M. (2022). Digital Economy and Environmental Quality: Insights from the Spatial Durbin Model. *International Journal of Environmental Research and Public Health*, 19 (23), Article 16094. https://doi.org/10.3390/ijerph192316094

Wang, X., Sun, X., Zhang, H., & Xue, C. (2022). Digital Economy Development and Urban Green Innovation CA-Pability: Based on Panel Data of 274 Prefecture-Level Cities in China. *Sustainability*, 14 (5), 2921. https://doi.org/10.3390/su14052921

Wang, Z., & Shi, P. (2021). Research and Analysis on the Index System of Digital Economy in Anhui Province. *Complexity*, 2021, 1-8. https://doi.org/10.1155/2021/5535864

Whitmore, A. (2012). A statistical analysis of the construction of the United Nations E-Government Development Index. *Government Information Quarterly*, 29 (1), 68-75. https://doi.org/10.1016/j.giq.2011.06.003

Wong, Y. C., Law, C. K., Fung, J. Y. C., Lam, J. C. Y. (2009). Perpetuating Old Exclusions and Producing New Ones: Digital Exclusion in an Information Society. *Journal of Technology in Human Services*, 27 (1), 57-78. https://doi.org/10.1080/15228830802459135

Wu, W. W., Lan, L. W., & Lee, Y. T. (2012). Exploring the critical pillars and causal relations within the NRI: An innovative approach. *European Journal of Operational Research*, 218 (1), 230-238. https://doi.org/10.1016/j.ejor.2011.10.013

Wu, Y. H., Bai, L., & Chen, X. (2023). How does FinTech affect the development of the digital economy? evidence from China. *Economic Research-Ekonomska Istrazivanja*, 36 (2), Article 2106278. https://doi.org/10.1080/1331677X.2022.2106278

Xia, L., Baghaie, S., & Sajadi, S. M. (2023). The digital economy: Challenges and opportunities in the new era of technology and electronic communications. *Ain Shams Engineering Journal*, 15 (2), 102411. https://doi.org/10.1016/j.asej.2023.102411

Xin, D., Yi, Y. & Du, J. (2022). Does digital finance promote corporate social responsibility of pollution-intensive industry? Evidence from Chinese listed companies. *Environmental Science and Pollution Research*, 29 (56), 85143-85159. DOI: 10.1007/s11356-022-21695-9

Xu, J., & Li, W. (2022). The Impact of the Digital Economy on Innovation: New Evidence from Panel Threshold Model. *Sustainability*, 14 (22), Article 15028. https://doi.org/10.3390/su142215028

Yalcin, N., & Ünlü, U. (2018). A multi-criteria performance analysis of Initial Public Offering (IPO) firms using CRITIC and VIKOR methods. *Technological and Economic development of Economy*, 24 (2), 534-560. https://doi.org/10.3846/20294913.2016.1213201

Yang, L., & Zhang, Y. (2020). Digital Financial Inclusion and Sustainable Growth of Small and Micro Enterprises—Evidence Based on China's New Third Board Market Listed Companies. *Sustainability*, 12 (9), Article 3733. https://doi.org/10.3390/su12093733

Yarovoy, T. S., Kozyrieva, O. V., Bielska, T. V., Zhuk, I. I., & Mokhova, I. L. (2020). The E-Government Development in Ensuring the Country Financial and Information Security. *Financial and Credit Activity: Problems of Theory and Practice*, 2, 268-275. https://doi.org/10.18371/fcaptp.v2i33.206853

Yera, A., Arbelaitz, O., Jauregui, O., & Muguerza, J. (2020). Characterization of e-Government adoption in Europe. *Plos One*, 15 (4), e0231585. https://doi.org/10.1371/journal.pone.0231585

Yerina, A., Honchar, I., & Zaiets, S. (2021). Statistical indicators of cybersecurity development in the context of digital transformation of economy and society. *Science and Innovation*, 17 (3), 3-13. https://doi.org/10.15407/scine17.03.003

Zanizdra, M., Harkushenko, O. M., Vishnevsky, V., & Kniaziev, S. (2021). Digital and Green Economy: Common Grounds and Contradictions. *Science and Innovation*. 17 (3), 14-27. https://doi.org/10.15407/scine17.03.014

Zelenkov, Y. A., & Lashkevich, E. V. (2020). Fuzzy regression model of the impact of technology on living standards. *Business Informatics*, 14 (3), 67-81. DOI: 10.17323/2587-814X.2020.3.67.81

Zhang, J., Zhao, W., Cheng, B., Li, A., Wang, Y., Yang, N., & Tian, Y. (2022). The Impact of Digital Economy on the Economic Growth and the Development Strategies in the post-COVID-19 Era: Evidence From Countries Along the "Belt and Road". *Frontiers in Public Health*, 10, Article 856142. https://doi.org/10.3389/fpubh.2022.856142

Zhao, F., Wallis, J., & Singh, M. (2015). E-government development and the digital economy: A reciprocal relationship. *Internet Research*, 25 (5), 734-766. https://doi.org/10.1108/IntR-02-2014-0055

Zhao, S., Zhang, Y., Iftikhar, H., Ullah, A., Mao, J., & Wang, T. (2022). Dynamic Influence of Digital and Technological Advancement on Sustainable Economic Growth in Belt and Road Initiative (BRI) Countries. *Sustainability*, 14 (23), Article 15782. https://doi.org/10.3390/su142315782

Zhao, Y., & Feng, Y. (2022). Research on the Development and Influence on the Real Economy of Digital Finance: The Case of China. *Sustainability*, 14 (14), Article 8227. https://doi.org/10.3390/su14148227

Zhou, Z., Zhang, Y., & Yan, Z. (2022). Will Digital Financial Inclusion Increase Chinese Farmers' Willingness to Adopt Agricultural Technology? *Agriculture*, 12 (10), Article 1514. https://doi.org/10.3390/agriculture12101514

Zou, F., Li, T., & Zhou, F. (2021). Does the Level of Financial Cognition Affect the Income of Rural Households? Based on the Moderating Effect of the Digital Financial Inclusion Index. *Agronomy,* 11 (9), Article 1813. https://doi.org/10.3390/agronomy11091813

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