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Impact of information and communications technology on the development and use of knowledge

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ABSTRACT

The development and capitalisation of knowledge have been defining the features of economic development in recent decades. This global trend leads to a constant search for success factors in knowledge economies. The Global Knowledge Index (GKI) is the leading international indicator of the quality of knowledge capital and the ability to build effective knowledge economies. Using GKI as the primary research indicator fostering knowledge-based economies, we assessed the role of information and communications technology (ICT) factors in its formation. GKI depends on subjective assessments of the impact of ICT factors on the development and use of knowledge set by experts. Here, we evaluate the effect of elements that are subject to statistical reporting and, therefore, most objectively reflect existing ICT trends in enterprises. Using the method of correlation-regression analysis and data from EU countries, we estimated the relationship of seven selected factors in the formation of GKI, establishing that significant links exist with six of seven studied elements. The closest links are with the indicators 'use of computers and the internet by employees' and 'enterprises with a website'. Additionally, continuing to test the hypothesis of a significant contribution of ICT to modern changes in the knowledge economy, we investigated their impact on GKI based on ICT development indicators assessed in the Network Readiness Index. The effect of this indicator is extremely high (R2 = 0.9287). Generally, the influence of ICT factors on knowledge development, and hence knowledge-based economies, allows one to identify the critical determinants of the success of leading countries. Our approach can be used to periodically monitor and select the most influential factors. Through reasonable efforts to stimulate the development of ICT, strengthening the role of such factors can make full use of current opportunities to create a knowledge-oriented economy.

1. Introduction

Over the past decades, and particularly during the pandemic period over the last 2 years, the role of remote interaction and the use of technological development advances has significantly increased. The unprecedented progress made by humanity during the pandemic's 'new normal' period has led to remarkable economic changes in intellectualisation and accelerated innovative development.

As per Deloitte, 'Coronavirus and its economic and social consequences are a time machine into the future. The changes that many of us predicted would take decades are happening in a matter of weeks' (Deloitte, 2020, p.2). Therefore, COVID-19 and the resultant changes in the labour market have become a significant catalyst for developing the knowledge economy, and further modifications are inevitable. For example, McKinsey analysts believe that fundamental changes in the labour market and related industries will occur within the next decade. Almost every role and industry worker must acquire new skills to adapt (McKinsey and Company, 2021); thus, significant prerequisites for developing a knowledge-based economy have not just been formed. Today's economy is no longer possible without rapidly developing information and communication technologies that require an increasingly high level of knowledge of users of such technologies in various areas, including daily relationships and business processes.

The leading indicator of the development of the knowledge economy

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remains the Global Knowledge Index (GKI), which comprehensively evaluates the human capital formed for intellectual development (at various levels of education and research) and efforts to develop the knowledge economy. Simultaneously, concerning information and communications technology (ICT), the overall coverage of technologies and government efforts to support the knowledge economy's proper IT infrastructure were evaluated as part of this global index. However, assessing the specifics of ICT use in business is not considered. In particular, this index does not consider the development of personnel skills and the use of business-specific opportunities, such as cloud technologies and big data. Simultaneously, the applied business aspect of ICT use in areas subject to statistical monitoring in enterprises today is an essential manifestation of the development of the knowledge economy and, simultaneously, the most productive field of ICT application. In this regard, our research proceeds from the methodological principles of assessing the impact of ICT on the development of the economy in various manifestations (competitiveness, sustainability and the ability to attract talent), defined in numerous scientific works in this direction, e.g. Akram et al., 2018; Mirzaaee and Ghaffari, 2018; Panda and Rath, 2021; Raudeliuniene et al., 2021; Santoro et al., 2021; Sarka et al., 2019. Nevertheless, the specifics of ICT application in the business environment in the context of the effectiveness of knowledge management processes (which determines the success of countries in building a knowledge economy) remain insufficiently researched.

Our research aims to determine the role of ICT (in particular, its use in enterprises) in forming the knowledge economy (the development level most comprehensively characterised by GKI). Furthermore, we identify the most influential ICT components and the development support contributing to creating a knowledge-based economy.

The study was conducted on the example of the countries of the European Union using relevant information on ICT development and use at enterprises from the Eurostat database (EC, 2021a-g), as well as information on the development of technologies in the Network Readiness Index (NRI) (Sterlite Technologies Limited, 2020). Additionally, the result in assessing achievements in creating a knowledge-based economy was evaluated on data on GKI in EU countries (UNDP, 2020).

The paper is organised into four sections. The second section presents a literature review that substantiates current research perspectives regarding ICT connections and the results of knowledge management in the economy. This review is the basis for our choice of factors and the substantiation of methodological bases for evaluating their connections. The third section presents the results. Finally, the fourth section summarises facts that can be used as a basis for developing recommendations for improving ICT use to promote the growth of the knowledge-based economy.

2. Literature review

At the current stage of socio-economic development, knowledge management is crucial in ensuring a country's competitiveness and sustainable economic growth (Barkhordari et al., 2019; Małkowska et al., 2021). The results of modelling the relationship between knowledge management and economic development at the macro level suggest that governments should support the development of information technologies at a high level to strengthen the competitiveness of their countries (Oliinyk et al., 2021).

Many indicators can measure knowledge economy development. Širá with colleagues (Širá et al., 2020) divide the indicators of the knowledge economy into two categories. The first category focuses on the basic characteristics of the knowledge economy, and this group of indicators describes the share of the knowledge economy in the country's whole economy. The second large group comprises the so-called performance or output indicators (the production of high-tech industries, high-tech exports, gross domestic product (GDP) growth, and labour productivity growth). The article (Leon, 2017) aims to analyse how the knowledge economy is measured and how different tools are developed for this purpose. The analysis concentrates on three of the most frequently used tools for measuring a country's progress towards consolidating itself as a knowledge economy: Knowledge Assessment Methodology developed by the World Bank, Lisbon Scorecard, elaborated by the World Economic Forum, and Innovation Union Scoreboard, created by the European Union. Nevertheless, the Kensho New Economies composite Index, the newest instrument developed by Kensho Technologies, is brought forward. The paper (Martínez et al., 2021) states that measuring the knowledge economy requires applying composite indicators. This study aims to propose and compare three MCA-DEA models from a 'Benefit of Doubt' approach to build KBE composite Indicators. This paper shows the effectiveness of the models by proposing a case study of 36 European countries to assess the degree of development of KBE. Scientists note that composite indicators are a remarkably useful tool in policy analysis and public communication for assessing phenomena such as a knowledge-based economy. Aliyev (Aliyev, 2021) notes the importance of the information component when measuring the knowledge economy. A methodology has been proposed for calculating the GDP generated by information and knowledge. A composite index of information and knowledge-based economy has been developed, along with corresponding hierarchic indices, sub-indices, and indicators.

ICT today includes hardware, software products, and services such as desktop computers, laptops, managed devices, wired or wireless internet, business productivity software, enterprise software, data storage, and network security (Hamad, 2018). Furthermore, the active use of such means in business significantly strengthens competitive advantages due to the development of online communications with stakeholders of enterprises and the activation of e-commerce. Both the enterprises and the economy receive positive economic consequences (Roshchyk et al., 2022).

The analysis of global ICT development trends and their use as a factor of competitive advantages proves that sustainable socio-economic growth has acquired signs of permanent digital development. Moreover, for developing countries, the rapid development of ICT can strengthen the new momentum of economic progress. This is confirmed by the correlation analysis and modelling of the impact of ICT factors on the financial results of enterprises and GDP per capita (Bilan et al., 2019). Therefore, in today's dynamic business environment, knowledge management and the widespread use of ICT are critical in developing competitive advantages at various hierarchical levels (Santoro et al., 2021; Bencsik and Juhasz, 2020; Portna et al., 2021). These include general economic growth (Máté et al., 2020), achieving sustainable financial results (Kavalić et al., 2021) and organisational efficiency (Slavic and Berber, 2019), business performance growth (Erdei et al., 2022), including that formed by the account of 'Learning and growth' factors (Pakurár et al., 2019) and management skills (Akimov et al., 2021; Panasiuk et al., 2021). Simultaneously, the actualisation of ICT contributes to positive economic and social changes, including reducing the level of corruption (Androniceanu et al., 2021), developing emotional intelligence and ethics (Mura et al., 2021), bringing psychological happiness and supporting the mental well-being of individuals and society (Saima et al., 2021).

Previous studies on the impact of ICT on knowledge management suggest that ICT play a significant role in implementing and supporting knowledge management and has a prominent role in knowledge management initiatives (Sefollahi, 2018). Furthermore, ICT is widely seen as a vital part of knowledge management, providing the means to create, share and acquire knowledge (Sarka et al., 2019; Radetić-Paić and Boljunčić, 2021; López-Cabarcos et al., 2021; Ko et al., 2021; Zhang et al., 2022).

One study's empirical results (Raudeliuniene et al. l, 2021) confirmed the hypothesis that information technology and social networks positively affect the knowledge management cycle, including the five primary processes: acquisition, creation, storage, exchange, and application of knowledge. Technical solutions enable monitoring

continuous information changes and knowledge development, storing massive databases and large volumes of information, and quickly exchanging knowledge, thus providing access to all stakeholders who need this knowledge (Bencsik, 2021).

At the microeconomic level, considerable empirical evidence indicates a positive relationship between ICT and organisational performance, measured by various indicators. Therefore, Akram et al. (2018) investigated the impact of information technology capabilities on the formation of sustainable competitive advantages of the organisation. Data from middle and senior managers from various organisations were used to test this effect. To evaluate the proposed relationships in the conceptual model, we used structural equation modelling using SmartPLS 3.2. The results confirm that organisational knowledge management capabilities partially mediate the relationship between information technology capabilities and performance, i.e. organisational performance and sustainable competitive advantage.

Bazrkar (2020) investigated the role of information technology in developing sustainable competitive advantages for organisations through implementing knowledge management. Structural equation modelling was used for data analysis based on collected information from 45 companies operating in Iran's e-insurance industry. The results showed that information technology is positively and significantly associated with a sustainable competitive advantage and organisational knowledge management. Therefore, the latter can ensure competitiveness by using appropriate IT tools and implementing a knowledge management system.

Mirzaaee and Ghaffari (2018) argue that knowledge is a crucial and strategic resource for acquiring assets and creating intangible organisational capabilities that can lead to further corporate growth, value creation, and competitiveness. The work examines the influence of information systems on knowledge exchange. The results demonstrate that components of information systems, such as service quality, system quality, and technology, play an essential role in exchanging knowledge between the organisation's personnel. The rapid exchange of information, in turn, ensures the effectiveness of organisational activities and improves interaction with internal and external stakeholders.

Roldán et al. (2018) assessed the role of knowledge management practices as a critical antecedent of knowledge management effectiveness. They examine how information technology infrastructure drives knowledge management productivity, organisational effectiveness, and innovation. The authors showed that knowledge management performance mediates between IT infrastructure on the one hand and organisational performance and innovation on the other. First, the IT infrastructure is a crucial effectiveness factor in knowledge management. Second, knowledge management indicators directly impact business performance and innovation implementation results (Pomegbe et al., 2020; d'Andria and Savin, 2018; Carayannis et al., 2018; Hidalgo and Herrera, 2020; Xu et al., 2021).

Panda and Rath (2021) identified the impact of ICT on organisational flexibility and adaptability in studying the relationship between information technology capabilities and knowledge management outcomes. Based on the results of a field survey of top management of business structures and IT personnel, they confirmed that competencies in the field of knowledge management are factors of organisational agility and flexibility.

Additional research (Masa'deh et al., 2019) investigates the role of knowledge management technological infrastructure in increasing job satisfaction. The results prove that the technical infrastructure of knowledge management significantly positively affects job satisfaction. Technology is one tool that contributes to creating new knowledge through information and communication systems to integrate fragmented information flows and technologies. Thus, barriers in communication between different structural units of the organisation are eliminated. Furthermore, employees' understanding of the benefits of knowledge management and their positive attitude towards such initiatives, expressed in the willingness to share and transfer knowledge, improve tacit retention of knowledge and contribute to fulfilling the organisation's strategic goals: increased work productivity and employee loyalty (Gaghman, 2019; Zhu et al., 2021). Another study (Martínez et al., 2021) uses the MCA-DEA approach to construct knowledge economy composite indicators.

Consequently, scientific research in ICT use is unanimous today that the purchase or development of software is a necessary component of knowledge management. However, the effectiveness of ICT use depends on the availability of qualified human resources capable of using digital tools to perform professional tasks. Therefore, ICT specialists' availability and training of employees to form their ICT skills are necessary for creating a knowledge-based economy.

3. Research model and hypotheses

Based on the purpose of the study, we set the following research tasks:

RQ1 – to assess the contribution of ICT used in business processes (based on objective statistical data on their development) to the formation of a knowledge-based economy;
RQ2 – to determine the impact on GKI of the indicator of ICT development, evaluated in the NRI within the pillar 'Technology'.

These two tasks complement each other since we use statistical data as factors characterising the development and use of ICT in business processes from commercial (which is characteristic of the statistical base used for RQ1) and purely technological (as this is typical of indicators in the composition of NRI) positions.

Within both research tasks, we chose the GKI as an indicator for evaluating the level of progress in forming a knowledge-based economy due to the effectiveness of knowledge management actions. GKI is a comprehensive indicator containing reliable data to help countries and economic entities make management decisions regarding the formation of the knowledge economy. In 2020, GKI covered 138 countries and contained seven sub-indices: pre-university education; technical and vocational education and training; higher education; research, development, and innovation; ICT; economy; and enabling environment (UNDP, 2020). These data help develop knowledge-based societies to overcome existing knowledge gaps based on the analysis of trends in technology, learning, innovation, and knowledge management infrastructure, having a corresponding impact on sustainable development. Notably, the GKI helps countries identify areas for investment to build an advanced, knowledge-based economy. Considering such features of GKI, it is currently the most informative international comparative indicator characterising the development of a knowledge-based economy. Thus, GKI fully meets our research goals.

4. Methodology

To achieve RQ1, we checked the absence of duplication of information on ICT use in the performance indicator (GKI) and factor indicators selected from the Eurostat database and NRI components.

The ICT sub-index within GKI comprises two parts: inputs, that is, what the government provides to support the development of a robust ICT infrastructure, and outputs—the use of ICT by private individuals, governments, and enterprises, considering their impact on development. Simultaneously, most indicators concern the general population; therefore, they are effective indicators of the quality of efforts to create and maintain ICT infrastructure for the people. Regarding the use of ICT in business processes, only separate assessments are included in the GKI. These are obtained based on expert judgements based on answers to different, somewhat generalised questions about ICT use in business. In particular, the indicators related to the use of ICT in the business environment as part of the GKI use experts' answers to the following questions (UNDP, 2020).

5.13 B2C internet use. To what extent do businesses use the internet to sell their goods and services to consumers in your country?
5.14 Firm-level technology absorption. In your country, to what extent do businesses adopt the latest technologies?
5.19 Impact of ICTs on business models. In your country, to what extent do ICTs enable new business models?

All these indicators are subjective variables based on a survey of managers' opinions. Therefore, their values reflect the personal beliefs and experience of the top management of organisations, which does not sufficiently illustrate objective changes in ICT use at enterprises.

Therefore, as factors influencing the knowledge economy, we used objective statistical indicators of ICT use in business processes that are subject to statistical monitoring by Eurostat in 27 countries of the European Union. Furthermore, the available statistical information on the website made it possible to identify seven leading indicators for evaluating such a relationship (Table 1).

Relationships between factors were tested using Spearman's correlation coefficient (Schober et al., 2018). After selecting the most significant factors, an economic-mathematical model of the impact of ICT on GKI was built using the built-in 'Regression' function in Excel.

To answer RQ2, we used data on the development of information technologies from the NRI index as factors, one of the most well-known global indices on ICT use and its economic impact. Additionally, over the past two decades, the NRI has established itself as one of the most comprehensive approaches to assessing the digital readiness of 130 world economies based on their performance, including 60 indicators (Portulans Institute, 2021).

Because network readiness is a multidimensional concept, NRI is a comprehensive index that contains four pillars: technology, people, management, and impact. Based on the research goal, the 'Technologies' sub-index—the basis of the network economy—was chosen to assess the impact of ICT on knowledge management. This direction aims to determine the level of technology, which is a prerequisite for the country's participation in the modern global economy. This sub-index is calculated on indicators divided into three groups: access, content, and future technologies.

As in the case of RQ1, the analysis was carried out based on economic-mathematical modelling using Excel. Again, as with the performance indicator (GKI), data for EU countries were used.

5. Data analysis

Within the framework of RQ1, we conducted a correlation analysis of the relationship between the factors listed in Table 1. The results of the correlation analysis confirmed the high importance of ICT in the EU countries for ensuring a high level of knowledge management; the values of six of seven correlation coefficients exceeded 0.6 (Table 2). Conversely, a weak influence on knowledge management is currently exerted by the employment of ICT specialists at enterprises (0.434).

Table 1
Indicators for evaluating the relationship between ICT and knowledge management.

Indicator	Unit of measurement	Symbol
Global knowledge index	Value	Y
Enterprises that employ ICT specialists	Percentage of enterprises	X_1
Use of computers and the Internet by employees	Percentage of total employment	X_2
Enterprises use DSL or another fixed broadband connection	Percentage of enterprises	X_3
Enterprises with a website	Percentage of enterprises	X_4
Enterprises that provided training to develop/upgrade the ICT skills of their personnel	Percentage of enterprises	X_5
Cloud computing services	Percentage of enterprises	X_6
Big data analysis	Percentage of enterprises	X_7

Source: authors' research.

In the correlation matrix (Table 2), to assess the relationship between ICT and knowledge management, correlation coefficients were calculated between the GKI (dependent variable Y) and statistical indicators of the use of ICT in business processes (independent variables X1–X7). The characteristics of these indicators are given in Table 1 of the Methodology section. The calculated correlation coefficients demonstrate the relationship between enterprises that employ ICT specialists, employees' use of computers and the internet, enterprises use of DSL or another fixed broadband connection, enterprises with a website, enterprises that provide training to develop/upgrade the ICT skills of their personnel, cloud computing services, big data analysis and GKI (Y).

The calculations show that the most significant influence on knowledge management is exerted by employees' use of computers and the internet (correlation coefficient value 0.840). Computer technology is a recognised and necessary means of finding, obtaining, storing and exchanging knowledge. Simultaneously, computer technology allows interaction with users, helping them to communicate freely and quickly with each other while ensuring the dissemination of learning throughout the organisation.

The availability of websites at enterprises is the second most important factor that significantly affects the level of knowledge management (correlation coefficient value 0.822). The development of a corporate website concerns its settings, easy navigation, and bright images, and implementing a website as one of the knowledge management tools provides enormous benefits to an organisation. With it, enterprise teams can create, organise, and share content with partners and consumers more effectively. Optimising information sharing and real-time collaboration are two of the most significant benefits of using web-based organisations. In a world where employees increasingly work remotely, online work allows one click to use solutions that support productivity and work satisfaction. The right business website is the one that helps firms continually improve the content, evolving as business scales and priorities change. It should become a brand promotion tool focused on achieving strategic results, supported by the organisation's key stakeholders.

Under the active development of high technologies, it is precious for employees to have ICT skills, which will ensure higher productivity in their work and help bring knowledge management in the organisation to a qualitatively higher level. Therefore, training to develop and improve staff ICT skills is an essential determinant of a high level of knowledge management (correlation coefficient value 0.708). The ICT competencies of personnel assume the existence of knowledge and ensure its availability, storage, search, and application. ICT skills mirror the ability to use information and communication technology tools to clearly define information problems, effectively access information, assess reliability and authority and organise and synthesise information for practical, responsible, and ethical use. Simultaneously, such skills help save time and provide conditions for the continuous development of employees, providing access to various online resources for improving professional skills.

Cloud computing services are increasingly in demand among European enterprises, having a positive effect on the level of knowledge management (correlation coefficient 0.695). Cloud computing includes various computing services—including servers, storage, databases, networks, software, analytics, and intelligence—over the internet (i.e. 'the cloud').

Businesses typically pay only for cloud services they directly use, allowing them to lower operating costs, manage their infrastructure more efficiently and scale their business growth. As a knowledge management tool, cloud computing is necessary for all organisations, regardless of their type, size or activity. The 'cloud' can be used for data backup, disaster recovery, software development and testing, email

Table 2
Results of a correlational analysis of the relationship between ICT and knowledge management.

Country	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7
Belgium	65.4	30	65	97	87	18	53	22
Bulgaria	48.3	16	34	86	52	5	11	6
Czechia	58.7	18	49	98	83	11	29	9
Denmark	68.3	29	77	100	93	18	67	24
Germany	66.2	19	59	95	88	12	33	17
Estonia	60.5	17	51	95	80	10	56	8
Ireland	66.1	30	59	92	75	12	51	22
Greece	46.8	19	45	89	60	8	17	12
Spain	57.9	17	56	91	75	9	26	6
France	64	18	61	96	70	8	27	20
Croatia	49.6	19	50	94	69	11	39	13
Italy	56.6	13	53	95	73	8	59	7
Cyprus	54.9	25	46	95	67	12	35	3
Latvia	55.1	20	44	86	63	7	21	7
Lithuania	55	16	55	93	78	7	31	9
Luxembourg	69.5	22	53	94	84	13	29	17
Hungary	53.9	29	45	83	63	8	25	6
Malta	59.7	29	52	95	83	16	53	29
Netherlands	69.7	24	72	95	84	15	53	26
Austria	65.4	20	63	92	90	11	38	7
Poland	54.3	25	50	85	71	8	24	8
Portugal	60.2	20	43	95	62	10	29	10
Romania	48.5	16	35	81	46	4	16	4
Slovenia	58.8	17	54	95	81	11	39	5
Slovakia	54.6	17	48	87	76	9	26	5
Finland	70.8	28	80	99	96	15	75	19
Sweden	70.6	21	83	94	90	11	70	13
Correlation coefficient	–	0.434	0.840	0.654	0.822	0.708	0.695	0.628

Source: (UNDP, 2020; EC, 2021a; EC, 2021b; EC, 2021c; EC, 2021d; EC, 2021e; EC, 2021f; EC, 2021g).

systems, virtual desktops, machine learning and analysis systems. The main advantages of using cloud computing in the field of knowledge management include (Hafizah et al., 2017) the following: (1) social support (the application allows for easier sharing of knowledge); (2) mobility (cloud computing can be used in any geographical space and at any time); (3) cost reduction (the price for using the technology is more flexible compared to a traditional software licence, as you only need to pay for its use); (4) compatibility (innovation can be applied to the user, as well as to the already existing value, and adapted to previous requirements) and (5) backup (a disaster recovery planning scenario for the equipment that is infected with a virus).

We used economic and mathematical modelling to identify the most influential factors for knowledge economy development, which should be applied in further management. A step-by-step assessment of the influence of the parameters listed in Table 2 regarding the level of knowledge management allowed us to determine a two-factor model (1) based on a multifactor regression model:

$$y = 25.909 + 0.2992x_2 + 0.2288x_4 \quad (1)$$

where y is the GKI value. x_2 is the use of computers and the internet by employees, as a percentage of total employees. x_4 represents enterprises with a website, as a percentage of enterprises.

The leading statistical indicators that confirm the statistical significance and adequacy of this model are given in Table 3.

The data in the table indicates that the relationship between GKI and the indicators characterising the use of computers and the internet by employees and the presence of websites in enterprises is quite tight. The multiple R correlation coefficients (0.867) and the values of the coefficient of determination (0.751) are close to 1. The coefficient of determination is 0.751. The constructed regression equation reproduces Y's dependence on the factors (X2 and X4) by 75.15 %, so the resulting indicator depends on these indicators by 75.15 %. The remaining 24.85 % is due to other factors not included in the model. Furthermore, the significance of the built correlation-regression model is evidenced by the calculated Fisher test, the estimated value of which (36.29) exceeds the corresponding critical value (3.40) at the given level of significance ($\alpha = 0.05$). Thus, the obtained regression equation is statistically significant.

Statistical indicators show that the built two-factor model is characterised by high theoretical capacity and is suitable for practical use (Table 4).

The Student's test was used to check the statistical significance of the model. The critical (table) value of the Student's criterion is 2.064, which is less than the calculated values of t-statistics (Table 4). This value confirms the theoretical capacity and static significance of this two-factor model. The free term of the correlation-regression model is b0 = 25.9090. This result means that with zero values for employees' use of computers and the internet and the number of enterprises with websites, the GKI takes an average value of 25.9090. If b1 = 0.2992, with a 1 % increase in employees' use of computers and the internet, the GKI value should increase by 0.2992 on average. If b2 = 0.2288, with a 1 % increase in the number of enterprises with websites, the GKI value should increase by 0.2288 on average. The *p*-values do not exceed 5 %,

Table 3
Indicators of the correlation-regression model.

Indicator	Value
Multiple R	0.8669
R-squared	0.7515
Normative R-squared	0.7308
Standard error	3.7704

Source: authors' research.

Table 4
Coefficients of the correlation-regression model.

Indicator	Coefficients	Standard error	t-statistics	p-value
Y-intersection	25.9090	4.5967	5.6364	0.0000
Variable X2	0.2992	0.1104	2.7106	0.0122
Variable X4	0.2288	0.1089	2.1011	0.0463
The critical value for this model is t	–	–	2.064	–

Source: authors' research.

indicating the adequacy of the obtained model and its high quality.

The dependence of the development of a knowledge-based economy (assessed by GKI) on the use of ICT is close and direct. That is, with an increase in the level of use of computer equipment and websites—as an essential means of communication with stakeholders and the dissemination of knowledge between them—the level of knowledge management increases. Therefore, ICT is primarily relevant for ensuring knowledge management in current conditions.

To achieve RQ2, we determined the impact of ICT development (assessed by the NRI approach) on progress in building a knowledge-based economy (evaluated by the GKI).

Data for assessing the impact of technologies on progress in building a knowledge-based economy across EU countries in 2020 are given in Table 5.

To determine the dependence of the level of knowledge management on technologies, we calculated the Pearson pair correlation coefficient according to the data in Table 5. Its value is 0.9637, proving the close relationship between the 'Technology' sub-index in the NRI and the GKI. The relationship between these indicators is direct; as the value of the 'Technology' sub-index increases, the value of the GKI also increases. Furthermore, the obtained pair correlation coefficient is statistically significant because the estimated value of the Student's criterion (18.04) exceeds the critical value (2.06).

To detail the relationship between the studied indicators, we developed an appropriate economic and mathematical model using Excel's built-in 'Regression' function (Fig. 1).

The economic and mathematical model has the form $y = 20.678 + 0.61114x$ and is statistically significant; the estimated value of Fisher's criterion (325.59) is greater than the critical value (4.24). As a result, the determination coefficient's value is near 1 ($R2 = 0.9287$); therefore, the GKI is explained to 92.87 % by the influence of technologies and only 7.13 % by the impact of factors not considered in the constructed model. Simultaneously, with an increase in the 'Technology' sub-index in the NRI by 1 %, the GKI value increases by 0.6114 on average. Therefore, the use of information technologies is an essential determinant of knowledge management for forming a knowledge-based economy.

Table 5
The value of the "Technology" sub-index in the Network Readiness Index and the Global Knowledge Index in 2020.

Country	Global Knowledge Index	"Technology" sub-index in the Network Readiness Index
Belgium	65.4	69.26
Bulgaria	48.3	50.13
Czechia	58.7	62.90
Denmark	68.3	79.71
Germany	66.2	79.18
Estonia	60.5	63.55
Ireland	66.1	72.10
Greece	46.8	51.37
Spain	57.9	62.96
France	64	69.52
Croatia	49.6	45.34
Italy	56.6	58.55
Cyprus	54.9	52.89
Latvia	55.1	52.80
Lithuania	55	56.10
Luxembourg	69.5	79.28
Hungary	53.9	56.43
Malta	59.7	61.60
Netherlands	69.7	83.81
Austria	65.4	70.47
Poland	54.3	52.99
Portugal	60.2	62.07
Romania	48.5	49.62
Slovenia	58.8	60.31
Slovakia	54.6	54.14
Finland	70.8	78.24
Sweden	70.6	83.82

Source: (UNDP, 2020; Sterlite Technologies Limited, 2020).

6. Conclusion and implications

In fostering a knowledge-based economy, understanding the role of economic growth factors has changed significantly in recent decades. As a result, the emphasis in modern research on knowledge development is increasingly related to the search for opportunities to multiply and implement this knowledge using the potential of ICT. Unfortunately, no scientific discussions discuss this direction; however, ideas about the composition of the most influential factors that bring the most remarkable economic profit remain rapidly changing.

6.1. Theoretical implications

This study contributes to the scientific literature in several ways. We modelled the dependence of the level of knowledge management on technologies for the global economic system, thus expanding the vision of scientists regarding the importance of ICT in certain types of economic activity, e.g. in agriculture, public administration, education or for individual countries (Ibrahim et al., 2020; Kalashi et al., 2020; Enakrire and Ocholla, 2017). Our approach allows for understanding the current role of ICT factors, combining the results of ICT use in an entrepreneurial activity aiming at performance and competitive advantages increase, typical for numerous studies (Akram et al., 2018; Bazrkar, 2020; Erdei et al., 2022; Mirzaaee and Ghaffari, 2018) with their gross impact on the national level. Thus, we emphasise that ICT constituents of knowledge management systems help achieve business goals. Such systems have a positive influence on knowledge-based economy development (measured by GKI) which is aligned with the findings obtained by Aliyev (2021), Bilan et al. (2019), Máté et al. (2020). Thus, it can be concluded that diminishing marginal productivity cannot be considered a current trend of ICT development. The novelty of our results in this regard is also connected with the approach to combine datasets from statistical sources with expert evaluation, which, in turn, makes it possible to enrich the database for a holistic understanding of knowledge economy amplification. With an understanding of the overall positive influence of the ICT factors in economic results formation, we emphasise the importance of finding the most clear links and the most influencing factors. According to our results, in the current stage of knowledge-based economic development, the most influencing factors are connected with the expansion of hardware and internet use by employees and the development of digital communication tools with stakeholders, like websites. Of course, influencing factors can change with further ICT development in business activity. Still, the proposed approach helps define the most impactful factors in each stage of knowledge management penetration in the economy. They should be the reliable basis for policy measures justification as a result. Furthermore, we closed the gap in ICT role investigations using data from the NRI and the GKI. The 'Technology' component of the NRI aims to assess the level of technology, which is a prerequisite for the country's participation in the global economy. The GKI is a road map for identifying bottlenecks and stimulating the development of knowledge-based economies. Thus, the obtained results make scientific progress using individual indices, such as the State ICT Development Index or the Digital Knowledge Economy Index (Ojanperä et al., 2019; Neamţu et al., 2019), when modelling the impact of ICT on knowledge management.

Scholars agree that ICT today is a complex concept that includes various technical tools, software products, and services (Hamad, 2018; Vu et al., 2020). Simultaneously, our study uses statistical indicators, such as enterprises that employ ICT specialists. We also include the use of computers and the internet by employees; enterprises that provided training to develop/upgrade the ICT skills of their personnel made it possible to single out human capital, along with technical means, as an integral factor in fostering knowledge-based economies. Unlike the previous findings in the field, our approach allows for defining the most urgent and influencing factors, which are employees' use of computers and the internet and the use of websites by enterprises. The set of

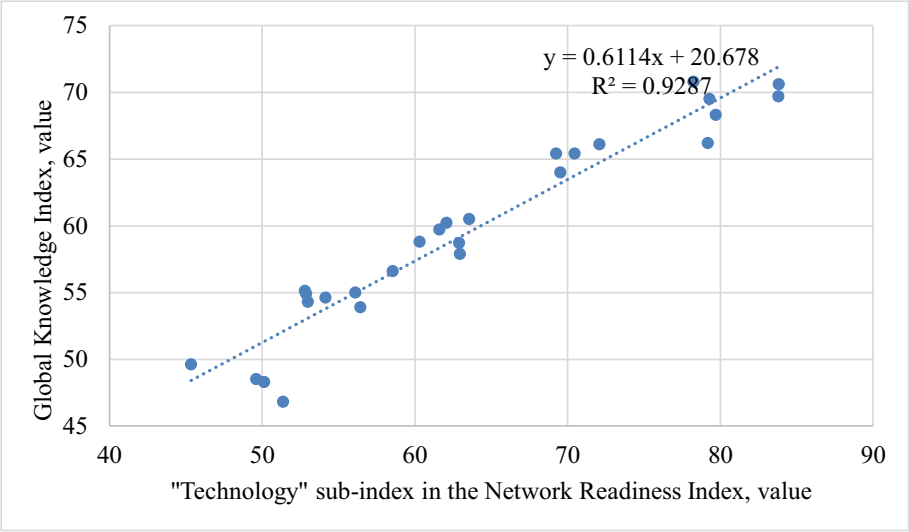

Fig. 1. Dependence of the Global Knowledge Index on the 'Technology' sub-index in the Network Readiness Index in 2020
Source: author's research.

variables can be modified with technological and societal changes. Our work offers the principal approach to define factors in the business environment essential for the overall growth of the knowledge economy. These links are not investigated in other works, which mainly focus on the general performance and economic growth results of ICT use (Aliyev, 2021; Oliinyk et al., 2021; Vu et al., 2020; Sefollahi, 2018; Zhu et al., 2021), or investigate the knowledge management indicators regarding their impact on countries' competitiveness (Barkhordari et al., 2019; Širá et al., 2020). Such research does not examine the initial prerequisites for knowledge management development in business with further macroeconomic effects.

6.2. Managerial implications

The results of this study are of critical practical implications for managers. The problem of finding economic growth factors is complicated because rapid changes in the composition and methods of using ICT are ahead of the development of the statistical base for their monitoring. Therefore, evaluations of ICT use, especially in business processes, despite their exceptional importance for modelling economic decisions, often involve a subjective approach. Simultaneously, objective statistical data on the use of ICT by enterprises is a more reliable basis for making managerial decisions regarding determining the most influential ICT factors. The reported data most accurately reflect the available resource and organisational capabilities of a business in the field of ICT use and provide opportunities for a generalised assessment at the macroeconomic level, devoid of the influence of subjectivism. Our analysis suggests that at the current status of forming a knowledge-based economy in EU countries, the most influential directions for involving ICT in business processes are providing employees with computers and internet usage opportunities (determined by the influence of the indicator 'use of computers and the internet by employees'. Furthermore, another vital direction is maintaining relations with stakeholders of enterprises through websites (which is revealed through connections with the factor 'enterprises with a website').

Equally important is the impact of factors of purely technological content (assessed within the framework of the NRI, pillar 'Technology'). This result proves the importance of supporting and developing ICT in enterprises in commercial directions (at the expense of further practical use of ICT for relations with internal and external stakeholders) and to further stimulating the development of technical capabilities to support such connections.

Thus, the results obtained in our study can be helpful for policy-making in two directions: in entrepreneurial activity and for the state regulatory policy development regarding knowledge-based activities support. The former is related to the methodology of analysis and justification of the most influencing factors for increasing business performance (and total economic outputs consequently). Our approach and the proposed database can be used for periodic monitoring of the ICT factors, fostering a knowledge-based economic activity and choosing the most relevant factors considering the current changes in technologies and knowledge-sharing trends. Government policy regarding the ICT-based aspects of knowledge economy growth can be developed or improved based on a similar approach. This approach should include a regular review of the current state and problems in ICT factors development in entrepreneurial and public administration spheres and contain the most impactful factors, facilitating their role in knowledge economy development. These functions could be considered in the activities of the National Productivity Boards, established according to the recommendations of the European Commission (2016). Currently, they have different names in member states and different areas of investigation with emphasis on labour productivity and investment, general issues in competitiveness and productivity growth. Of course, the aim and scope of these boards' activity depend on national priorities of development defined in certain states.

However, considering the growing role of a knowledge economy and the factors fostering it, it seems vital to pay more attention to ICT factors among other directions of the activities of National Productivity Boards activity, implementing appropriate research with respect to the regular monitoring of these public entities.

6.3. Limitations and future research

The proposed approach can be used for systematic studies of changes in the composition of ICT, which determine the possibilities of fostering a knowledge-based economy to the greatest extent. However, choosing such connections and modelling their impact is complicated by the dynamic development of ICT itself, which requires periodic updates of the methodological base for monitoring these changes. Such changes are a particularly limiting factor in empirical studies on the impact of ICT on economic development.

Simultaneously, further research on the use of ICT by enterprises is essential since the potential and effectiveness of ICT use in business processes ultimately determines the effectiveness of creating a

knowledge-based economy, the construction of which is a modern reference point for most countries of the world. Additionally, as proven by the recent experience of massive sudden business shutdowns and the global destruction of numerous traditional methods of communication under the influence of the pandemic, rapid adaptation to new conditions using ICT in business processes can significantly weaken the negative impact of external threats on enterprises, thus stabilising economic activity relatively quickly. In this regard, we include the study of the determinants and problems of ICT development at the level of enterprises as prospects for further research. Such research can focus on the organisational component that determines the success of enterprises in creating and disseminating new knowledge using ICT, in particular, through knowledge management systems.

Declaration of competing interest

Authors declare they do not have any competing financial, professional, or personal interests from other parties.

Data availability

Data will be made available on request.

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Author contributions

Olena Oliinyk, Halyna Mishchuk, Yuriy Bilan' conceived the study and were responsible for the data collection, design and development of the data analysis as well as for data interpretation. Olena Oliinyk, Halyna Mishchuk, Yuriy Bilan wrote the first draft of the article. All authors have approved the manuscript submission. Marinko Škare was in charge on draft revision and manuscript final preparation according to the author guidelines.

CRediT authorship contribution statement

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Yuriy Bilan: Data curation, Writing- Original draft

Marinko Škare: Supervision, Validation, Writing- Reviewing and Editing

References

Akimov, O.O., Karpa, M.I., Parkhomenko-Kutsevil, O., Kupriichuk, V., Omarov, A., 2021. Entrepreneurship education of the formation of the e-commerce managers professional qualities. Int.J. Entrep. 25 (7), 1–8.

Akram, M.S., Goraya, M.A.S., Malik, A., Aljarallah, A.M., 2018. Organizational performance and sustainability: exploring the roles of IT capabilities and knowledge management capabilities. Sustainability 10, 3816. https://doi.org/10.3390/su10103816.

Aliyev, A.G., 2021. Development system of hierarchical indicators for analyzing and measuring the level of growth of information and knowledge economy. In: Management Dynamics in the Knowledge Economy, 9, pp. 65–80.

Androniceanu, A., Nica, E., Georgescu, I., Sabie, O.M., 2021. The influence of the ICT on the control of corruption in public administrations of the EU member states: a comparative analysis based on panel data. Adm. Manag. Public 37, 41–59. https://doi.org/10.24818/amp/2021.37-03.

Barkhordari, S., Fattahi, M., Azimi, N.A., 2019. The impact of knowledge-based economy on growth performance: evidence from MENA countries. J. Knowl. Econ. 10, 1168–1182. https://doi.org/10.1007/s13132-018-0522-4.

Bazrkar, A., 2020. The investigation of the role of information technology in creating and developing a sustainable competitive advantage for organizations through the implementation of knowledge management. J. Spat. Org. Dyn. 8 (4), 287–299.

Bencsik, A., 2021. The sixth generation of knowledge management – the headway of artificial intelligence. J. Int. Stud. 14 (2), 84–101. https://doi.org/10.14254/2071-8330.2021/14-2/6.

Bencsik, A., Juhasz, T., 2020. Impacts of informal knowledge sharing (workplace gossip) on organisational trust. Econ. Sociol. 13 (1), 249–270. https://doi.org/10.14254/2071-789X.2020/13-1/16.

Bilan, Y., Mishchuk, H., Samoliuk, N., Grishnova, O., 2019. ICT and economic growth: links and possibilities of engaging. IntellectualEconomics 13 (1). https://doi.org/10.13165/IE-19-13-1-07.

Carayannis, E.G., Giudice, M.G., Soto-Acosta, P., 2018. Disruptive technological change within knowledge-driven economies: the future of the internet of things (IoT). Technol. Forecast. Soc. Chang. 136, 265–267. https://doi.org/10.1016/j.techfore.2018.09.001.

d'Andria, D., Savin, I., 2018. A win-win-win?Motivating innovation in a knowledge economy with tax incentives. Technological Forecasting and Social Change 127, 38–56. https://doi.org/10.1016/j.techfore.2017.05.030.

Deloitte, 2020. Thriving in the "new" normal. In: Minimizing Risks to Workforce Safety While Maximizing Productivity. https://www2.deloitte.com/content/dam/Deloitte/de/Documents/human-capital/Deloitte-Deutschland-Mitarbeiterproduktivit%C3%A4t-steigern-Risiko-minimieren-nach-Lockdown-web.pdf.

EC, 2021. Big Data Analysis. https://ec.europa.eu/eurostat/databrowser/view/isoc_eb_bd/default/table?lang=en.

EC, 2021. Cloud computing services. https://ec.europa.eu/eurostat/databrowser/view/ISOC_CICCE_USE_custom_2032702/default/table?lang=en.

EC, 2021. Enterprises That Employ ICT Specialists. https://ec.europa.eu/eurostat/databrowser/view/isoc_ske_itspen2/default/table?lang=en.

EC, 2021. Enterprises that provided training to develop/upgrade ICT skills of their personnel. https://ec.europa.eu/eurostat/databrowser/view/isoc_ske_ittn2/default/table?lang=en.

EC, 2021. Enterprises with a website. https://ec.europa.eu/eurostat/databrowser/view/ISOC_CIWEB_custom_2032530/default/table?lang=en.

EC, 2021. Type of connections to the Internet. https://ec.europa.eu/eurostat/databrowser/view/ISOC_CI_IT_EN2_custom_2032467/default/table?lang=en.

EC, 2021. Use of computers and the Internet by employees. https://ec.europa.eu/eurostat/databrowser/view/isoc_ci_cm_pn2/default/table?lang=en.

Enakrire, R.T., Ocholla, D., 2017. An overview of the status, challenges and opportunities of ICT for knowledge Management in University libraries in Nigeria. S. Afr. J. Inf. Manag. 19, 1–9. https://doi.org/10.4102/sajim.v19i1.750.

Erdei, E., Kossa, G., Kovács, S., Popp, J., Oláh, J., 2022. Examining the correlations between industry 4.0 assets, external and internal risk factors and business performance among Hungarian food companies. Amfiteatru Econ. 24 (59), 143–158.

European Commission, 2016. Council recommendation of 20 September 2016 on the establishment of National Productivity Boards (2016/C 349/01). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32016H0924%2801%29.

Gaghman, A., 2019. The impact of individual behavioural factors on tacit knowledge retention in oil and gas organisations. Eur. J. Intercult. Stud. 11 (1), 18–28.

Hafizah, N., Daud, M., Rahman, S.A., 2017. Advantages of using cloud computing by knowledge management personnel. Int. J. Acad. Res. 7 (11), 908–916.

Hamad, W.B., 2018. The role of ICT in knowledge management processes: a review. Int. J. Eng. Sci. Comput. 8 (3), 16373–16380.

Hidalgo, A., Herrera, R., 2020. Innovation management and co-creation in KIBs: an approach to the ICT services sector. Technol. Forecast. Soc. Chang. 161 (12027) https://doi.org/10.1016/j.techfore.2020.120278.

Ibrahim, W., Mohd Daud, N., Hassan, R., 2020. The roles of ICT for knowledge management in agriculture. Int. J. Technol. Manag. Inf. Syst. 2 (2), 1–13. URL. https://myjms.mohe.gov.my/index.php/ijtmis/article/view/9166.

Kalashi, M., Bakhshalipour, V., Azizi, B., Sareshkeh, S.K., 2020. The effect of the application of ICT skills on the process of knowledge management components and the effectiveness of creativity indicators for the improvement of employees' performance system in the Ministry of Sports and Youth. World J. Educ. Technol. 12 (1), 048–062. https://doi.org/10.18844/wjet.v12i1.4382.

Kavalić, M., Nikolić, M., Stanisavljev, S., Đorđević, D., Pečujlija, M., Stojanović, E., 2021. Knowledge management and financial performance in transitional economies: the case of Serbian enterprises. J. Bus. Econ. Manag. 22 (6), 1436–1455. https://doi.org/10.3846/jbem.2021.15540.

Ko, E.J., Kim, A.H., Kim, S.S., 2021. Toward the understanding of the appropriation of ICT-based smart-work and its impact on performance in organizations. Technol. Forecast. Soc. Chang. 171, 120994 https://doi.org/10.1016/j.techfore.2021.120994.

Leon, R., 2017. Measuring the knowledge economy: a national and organizational perspective. Manage. Dyn. Knowl. Econ. 5, 227–249. https://doi.org/10.25019/MDKE/5.2.04.

López-Cabarcos, M.A., Piñeiro-Chousa, J., Quiñoá-Piñeiro, L., 2021. An approach to a country's innovation considering cultural, economic, and social conditions. Econ. Res.-Ekon. Istraz. 34 (1), 2747–2766. https://doi.org/10.1080/1331677X.2020.1838314.

Małkowska, A., Urbaniec, M., Kosała, M., 2021. The impact of digital transformation on European countries: insights from a comparative analysis. Equilibrium. Quarterly Journal of Economics and Economic Policy 16 (2), 325–355. https://doi.org/10.24136/eq.2021.012.

Martínez, J.M.G., Martín, J.M.M., Rey, M.S.O., de Castro Pardo, M., 2021. Constructing knowledge economy composite indicators using an MCA-DEA approach. Econ. Res.-Ekon. Istraz. 34 (1), 331–351. https://doi.org/10.1080/1331677X.2020.1782765.

Masa'deh, R., Almajali, D.A., Alrowwad, A., Obeidat, B., 2019. The role of knowledge management infrastructure in enhancing job satisfaction: A developing country

perspective. Interdisciplinary Journal of Information, Knowledge and Management 14, 1–25.
Máté, D., Erdei, E., Lorestani, V.Z., Popp, J., Oláh, J., 2020. Can internet in schools and technology adoption stimulate productivity in emerging markets? Econ. Sociol. 13 (1), 182–196.
McKinsey &amp, Company, 2021. The Next Normal. https://www.mckinsey.com/featured-insights/the-next-normal.
Mirzaaee, S., Ghaffari, A., 2018. Investigating the impact of information systems on knowledge sharing. J. Knowl. Manag. 22 https://doi.org/10.1108/JKM-08-2017-0371.
Mura, L., Zsigmond, T., Machová, R., 2021. The effects of emotional intelligence and ethics of SME employees on knowledge sharing in central-european countries. Oecon. Copernic. 12 (4), 907–934. https://doi.org/10.24136/oc.2021.030.
Neamţu, D.M., Hapenciuc, C.V., Bejinaru, R., 2019. The impact of digitalization on business sector development in the knowledge economy. In: Proceedings of the international conference on business excellence, 13:1, pp. 479–491.
Ojanperä, S., Graham, M., Zook, M., 2019. The digital knowledge economy index: mapping content production. J. Dev. Stud. 55 (12), 2626–2643. https://doi.org/10.1080/00220388.2018.1554208.
Oliinyk, O., Bilan, Y., Mishchuk, H., 2021. Knowledge management and economic growth: the assessment of links and determinants of regulation. Cent. Eur. J. Manag. 29 (3), 20–39. https://doi.org/10.7206/cemj.2658-0845.52.
Pakurár, M., Haddad, H., Popp, J., Khan, T., Oláh, J., 2019. Supply chain integration, organizational performance and balanced scorecard: an empirical study of the banking sector in Jordan. J. Int. Stud. 12 (2), 129–146. https://doi.org/10.14254/2071-8330.2019/12-2/8.
Panasiuk, O., Akimova, L., Kuznietsova, O., Panasiuk, I., 2021. Virtual laboratories for engineering education. In: 2021 11th International Conference on Advanced Computer Information Technologies (ACIT) - Proceedings, pp. 637–641. https://doi.org/10.1109/ACIT52158.2021.9548567.
Panda, S., Rath, S.K., 2021. Information technology capability, knowledge management capability, and organizational agility: the role of environmental factors. J. Manag. Organ. 27 (1), 148–174. https://doi.org/10.1017/jmo.2018.9.
Pomegbe, W.W.K., Li, W., Dogbe, C.S.K., Otoo, C.O.A., 2020. Enhancing the innovation performance of small and medium-sized enterprises through network embeddedness. J. Competit. 12 (3), 156–171. https://doi.org/10.7441/joc.2020.03.09.
Portna, O.V., Iershova, N.Y., Tereshchenko, D.A., Kryvytska, O.R., 2021. Economic business partnerships within industry 4.0: new technologies in management. Montenegrin Journal of Economics 17 (10), 151–163.
Portulans Institute, 2021. Introducing the Network Readiness Index 2021. https://networkreadinessindex.org/introducing-the-network-readiness-index-2021/.
Radetić-Paić, M., Boljunčić, V., 2021. The causes of I.C.T. Use which increase time spent on the internet by secondary school students and affect exposure to bullying from other students. Econ. Res.-Ekon. Istraz. 35 (1), 2859–2867.
Raudeliuniene, J., Albats, E., Kordab, M., 2021. Impact of information technologies and social networks on knowledge management processes in middle eastern audit and consulting companies. J. Knowl. Manag. 25 (4), 871–898. https://doi.org/10.1108/JKM-03-2020-0168.
Roldán, J., Real, J., Ceballos, S., 2018. Antecedents and consequences of knowledge management performance: the role of IT infrastructure. Intang. Cap. 14 (4), 518. https://doi.org/10.3926/ic.1074.
Roshchyk, I., Oliinyk, O., Mishchuk, H., Bilan, Y., 2022. IT products, E-commerce, and growth: analysis of links in emerging market. Transform. Bus. Econ. 21 (1), 209–227.
Saima, H., Rizwan Raheem, A., Aamir Feroz, Sh., 2021. Technology confirmation is associated to improved psychological well-being: evidence from an experimental design. Transform. Bus. Econ. 20 (2), 177–196.
Santoro, G., Thrassou, A., Bresciani, S., Giudice, M.D., 2021. Do knowledge management and dynamic capabilities affect ambidextrous entrepreneurial intensity and firms' performance? Transform. Bus. Econ. 68 (2), 378–386. https://doi.org/10.1109/TEM.2019.2907874.
Sarka, P., Heisig, P., Caldwell, N.H.M., Maier, A.M., Ipsen, C., 2019. Future research on information technology in knowledge management. Knowl. Process. Manag. 26 (3), 277–296. https://doi.org/10.1002/kpm.1601.
Schober, P., Boer, C., Schwarte, L.A., 2018. Correlation coefficients: appropriate use and interpretation. Anesth. Analg. 126 (5), 1763–1768.
Sefollahi, N., 2018. The importance of ICT on knowledge management in organizations. J. Fund. Appl. Sci. 10 (2), 431–448.
Širá, E., Vavrek, R., Kravčáková Vozárová, I., Kotulič, R., 2020. Knowledge economy indicators and their impact on the sustainable competitiveness of the EU countries. Sustainability 12, 4172. https://doi.org/10.3390/su12104172.
Slavic, A., Berber, N., 2019. The role of training practice in improving organizational performance in selected countries of the Danube region. Inzinerine Ekonomika-Eng. Econ. 30 (1), 81–93. https://doi.org/10.5755/j01.ee.30.1.17857.
Sterlite Technologies Limited, 2020. The Network Readiness Index 2020. https://www.stl.tech/nri-2020-report/.
UNDP, 2020. Global Knowledge Index 2020. https://www.undp.org/publications/global-knowledge-index-2020.
Vu, K., Hanafizadeh, P., Bohlin, E., 2020. ICT as a driver of economic growth: a survey of the literature and directions for future research. Telecommun. Policy 44, 101922. https://doi.org/10.1016/j.telpol.2020.101922.
Xu, A., Cheng, C., Qiu, K., Wang, X., Zhu, Y., 2021. Innovation policy and firm patent value: evidence from China. Econ. Res.-Ekon. Istraz. 35 (1), 2615–2644. https://doi.org/10.1080/1331677X.2021.1970607.
Zhang, Z., Wang, Z., Zhu, Y., 2022. Optimal path selection of innovation resource allocation in China's regions with shared inputs. Economic Research-Ekonomska Istraživanja 35 (1), 1457–1480. https://doi.org/10.1080/1331677X.2021.1969979.
Zhu, F., Li, Q., Yang, S., Balezentis, T., 2021. How ICT and R&D affect productivity?Firm level evidence for China. Economic Research-Ekonomska Istraživanja 34 (1), 3468–3486. https://doi.org/10.1080/1331677X.2021.1875861.

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