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DEVELOPMENT OF A METRIC FOR ASSESSING THE COMPETITIVENESS OF UKRAINE ACCORDING TO THE PROGRESS OF THE DIGITAL TRANSFORMATION OF THE ECONOMY

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Ukraine's prioritization of entry into the European digital market as a foreign policy direction highlights the urgency of incorporating the global digital economy and society index (DESI) into the national statistical monitoring system. The article asserts that DESI introduction is a pressing issue. It was emphasized that although Ukraine has declared its integration into the EU's single digital market, the country is not currently participating in any international rating to assess the competitiveness of its digitalization progress. This is due to the absence of any strategic or conceptual documents that support the use of indices of the country's digital evolution. By not implementing new and improved tools for measuring digitalization as a factor of economic growth, Ukraine is severely limited in reflecting the use and impact of digital technologies, such as AI, data analytics, IoT, 3D print, automation and robots, Cloud, 5G mobile broadband, and blockchain, on the aggregate value added of different economic sectors. Currently, only the metric for determining the Digital Transformation Index of Ukraine's regions has been approved in Ukraine at the official level. However, this metric does not meet the requirements of Eurostat and therefore cannot be utilized for international comparison. It is imperative that the global Digital Economy and Society Index (DESI) metric is implemented in Ukraine's domestic practice. The constituent elements of DESI, which include connectivity, human capital, use of internet services, integration of digital technology, and digital public services, must be taken into consideration. Accordingly, an assessment was conducted to determine Ukraine's readiness for the implementation of DESI. It is justified that Ukraine's participation in the formation and presentation of information about the DESI index will allow not only to have an objective assessment of the country's place in global trends, but also to have extremely important information for international investors regarding Ukraine's confirmation of commitment to the principles of openness and transparency assumed by international obligations to enter the single digital market by harmonizing its statistical system with EU standards and practices.

Keywords: digitalization of the economy, digital competitiveness, digital market, digital development.

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Formulation of the problem

In the conditions of growing competition, the traditional model of Ukraine's economy cannot ensure its functioning at the achieved level and cannot guarantee efficiency in the future. The digital

transformation of the economy is generally recognized as an accelerator of socio-economic development and a tool for ensuring long-term competitive advantages [1, p.118].

H. Aly [2, p.253] demonstrated a positive

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relationship between digital transformation, economic development, and labor productivity. Additionally, rapid technological advancements bring substantial benefits to developing countries through digital transformation.

However, digital transformation, affecting the acceleration of economic development in complex and interconnected ways, determines the need for clear and agreed rules (metrics), as well as tools for measuring the level of digitalization as a basis for assessing domestic digital development, and therefore, determining areas that need priority measures to attract investments and create a single digital market [3].

S. Kunkel and M. Matthess [4] utilized pre-existing ICT assessment frameworks that differentiate between information and communication technologies (ICTs) lifecycle-based direct environmental impacts and indirect environmental effects resulting from ICT application in various production processes and economic activities and their analysis revealed that the expectations surrounding the use of ICTs are ambiguous, with a greater emphasis placed on their positive indirect impacts, such as enhanced energy efficiency and resource management, rather than negative direct impacts, like the electricity consumption of ICTs. Furthermore, there are variations in expectations between countries [4]. Anyway, the use of green energy is also crucial in digitalized companies [5].

In international practice, metrics and tools for measuring digital development have become widespread since 2017. In Ukraine, unfortunately, the process of collecting data on the digitalization of the economy remains relatively undeveloped, as a result of which a number of problems arise, including and the lack of a possibility to compare indicators of the development of the digital economy of Ukraine with other countries.

The backwardness of Ukraine in the implementation of new and improved tools of the evidence base for measuring digitization as a factor of economic growth significantly narrows the ability to reflect in the domestic economy the use and impact on the aggregate added value of digital technologies, in particular such as artificial intelligence and data analysis, the Internet of Things, 3D printing, automation and robotics, cloud computing, 5G mobile broadband, blockchain technologies in various sectors of the economy [3]. Therefore, the issue of implementation in domestic practice of metrics for assessing the country's competitiveness based on the progress of the digital transformation of the economy requires an urgent solution, which justifies the relevance of the chosen research topic.

Analysis and research of publications shows that the topic of digitalization of the Ukrainian economy is quite popular among scientists and practitioners. It is studied both at the national and regional level, and at the level of regions and territorial communities. In particular, E. Buriak, K. Redko, S. Sirtseva, O. Shuplat [6], M. Varlamova and Yu. Demyanova [7] have been working for a long time on the development of indicators for measuring digital transformation and the formation of the Digitalization Index of the country's economy. Yu. Rogozyan and V. Vakhlakova [8] in their works demonstrate certain aspects of evaluating the effectiveness and efficiency of the process of digitalization of the economy at the level of regions and territorial communities, emphasizing that the methodological basis for determining the index of digital transformation of regions formed by the Ministry of Digital Transformation of Ukraine does not take into account a number of areas, among which: the presence and activity of CDTO in the regions, the implementation of the digital tool Diia. Signature, information on the presence and functioning of local open data web portals in the regions and their degree of occupancy, the availability of services in the territories of the regions, etc. [8]. Oliynyk D. [3], based on world experience (in particular, Great Britain, EU countries, Japan, etc.) provides clear recommendations on improving the measurement of the progress of the digitization process in Ukraine.

Purpose of the article

The purpose of the article is to carry out a comprehensive study of Ukraine's capability to implement a metric for assessing the country's competitiveness based on the level of progress in the digital transformation of the economy, introduced by the European Commission with the adoption of the “Digital Decade towards 2030” program.

Presentation of the main material

As global society continues to advance technologically and innovate, it is evident that we are in the midst of the Fourth Industrial Revolution (sometimes called Computer Revolution). The accelerating digitalization of businesses and the economy at large accompanies this revolution. However, it is unclear how quickly Ukraine is adapting to these changes. Although there exist numerous metrics worldwide used to assess a country's competitiveness in digital economy digitization, in Ukraine, only the Digital Transformation Index (DTIr) has official approval. The DTIr index comprises three data types:

– binary, which are transformed into numerical values (in particular, the answer “Yes” is coded as 1, and “No” – as 0);

– quantitative;
– qualitative, determined by the results of expert evaluations [9].

The definition of DTIr entails transforming incoming information in eight key areas: institutional capacity, Internet development, National Social Security System development, paperless processes, digital education, regional representation, basic e-service penetration, and industry digital transformation. This involves several stages, with each stage averaging the value of the previous one. At each stage, a weighting factor is introduced to prioritize specific variables. Simultaneously, the weighting coefficients are calculated based on the priority of each characteristic within the indicator, the indicator within the subindex, and the subindex within the index (Fig. 1).

The metric for determining the DTIr is based

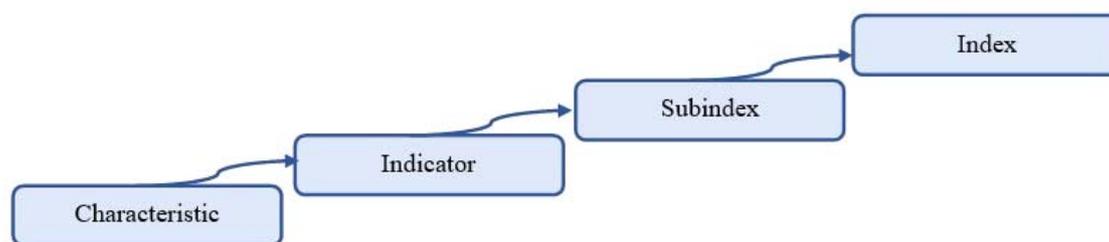


Fig. 1. Structural elements of the Digital Transformation Index of the regions of Ukraine according to the metrics of the Ministry of Digital Transformation of Ukraine [9]

24 regions of Ukraine, allows determining DTI in the country as a whole. That is why, there is no need to develop a metric for determining DTI in the country as a whole. Nevertheless, upon a more detailed study, we observe that the metric for defining DTIr does not fully correspond to any of the metrics that have become widespread in European practice, that:

firstly, it makes it impossible for Ukraine to participate in international ratings of the competitiveness of countries according to the level of progress of digitalization of the economy;

secondly, it makes it difficult to attract foreign investment in the development of the country's digital industry;

thirdly, it is a barrier to carrying out a comparative analysis of the progress of digitalization of the economy of Ukraine and other European countries.

Since Ukraine has embraced European integration, its framework for digitalizing the economy aligns with the European Union's "Digital Europe" program (2021-2027) and "Digital Agenda for Europe" (Digital Single Market Strategy), designed to bolster EU digital policy [10, 11]. Thus, the metric for

on the aggregation of indicator values, the normalization of which should be carried out according to the min-max principle (minimum-maximum value of the indicator). After normalization and aggregation of values, the data are grouped by gradation of values into four groups:

$0 \leq 0.25$;
 $>0.25 \leq 0.50$;
 $>0.50 \leq 0.75$;
 $>0.75 \leq 1.00$ [9].

When the DTIr approaches a value of 1, it indicates the region's economy has achieved the highest level of digitalization progress.

Therefore, at first glance, it seems that the DTIr determined in this way separately for each of the

calculating the Digital Economy and Society Index (DESI), specified by the European Commission, should complement the mentioned frameworks.

DESI is a composite index that summarizes relevant indicators of digital performance and tracks the evolution of EU member states along four main dimensions: human capital, connectivity, integration of digital technologies and digital public services [12]. For its definition, the EC has chosen a number of indicators, which are conditionally divided by thematic groups, illustrating some key dimensions of the European information society (in particular, the telecommunications sector, broadband, mobile communication, Internet use, Internet services, e-government, e-commerce, e-business, ICT skills, research and development).

Fig. 2 demonstrates the progress of the EU Member States according to the latest DESI ranking in 2022 over the last 5 years.

For each country, the graph shows the relationship between DESI indicators in 2017 (horizontal axis) and average annual DESI growth in the period 2017-2022 (vertical axis). As in the classical

theory of economic growth, general convergence is demonstrated when countries starting with lower levels of digital development grow at a faster rate (left side of the diagram). DESI indicators clearly demonstrate the overall picture of convergence in the EU between 2017 and 2022 [13].

The predicted convergence model is represented by the blue line in the figure. Countries situated above this line depict a higher rate of digital transformation of their economy than what is expected according to the convergence curve. Based on the data in Fig. 2, Italy emerges as the top-performing country among

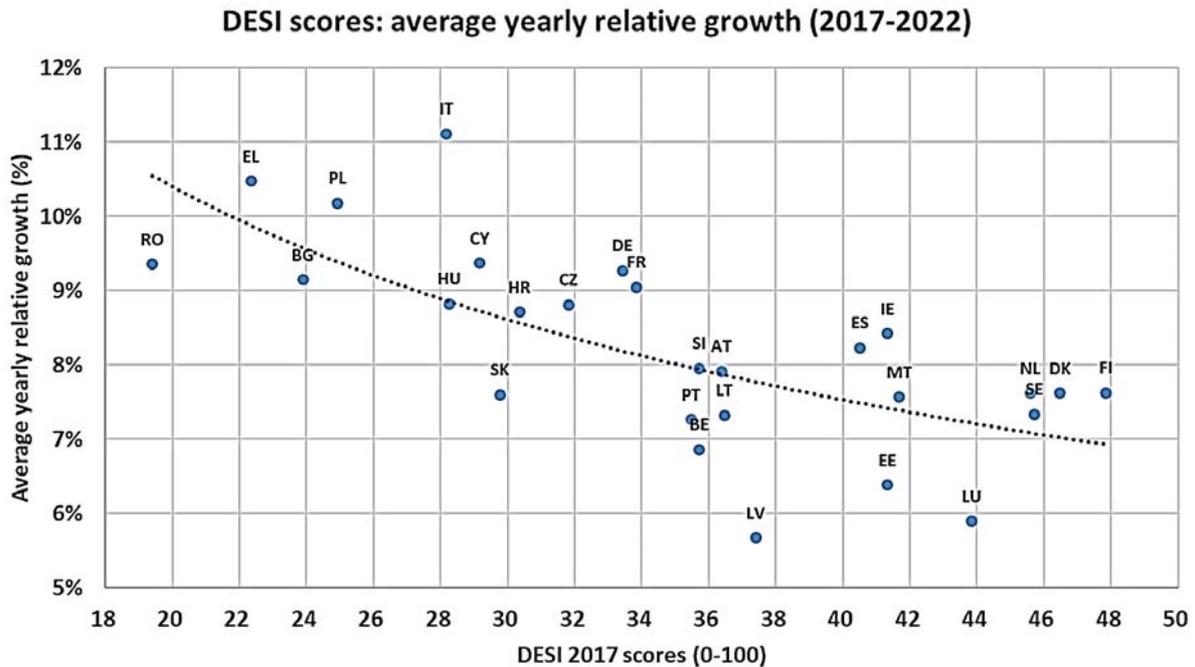


Fig. 2. Digital Economy and Society Index – Member States’ relative progress in the period 2017-2022 [13]

the leaders. The country’s economy underwent digitization during the studied period at a significantly faster pace than anticipated. It is followed by Germany, Ireland, France, and Poland, which comprise the top five leading countries in progressing the digital transformation of their economies [13].

The opposite picture is observed for countries located below the blue line. Yes, Latvia improved its DESI score at a much slower pace than expected. Luxembourg, Romania, Belgium, Slovakia and Estonia also deviate significantly from the convergence curve.

We can clearly observe the deviation of the percentage of the rates of digital transformation of the economies of countries from the convergence curve in Fig. 3.

Thus, the highest percentage deviation of the rate of progress of the digital transformation of the countries’ economy from the expected one (more than 2%), as mentioned earlier, is observed in Italy, the lowest (also more than 2%) – in Latvia.

Which of the components of DESI (human capital, connectivity, integration of digital technologies

and digital public services) and how they influenced its deviation from the expected convergence curve can be seen by turning to Fig. 4.

Based on Fig. 4, human capital, specifically a competent workforce and a digitally literate population, is the primary factor influencing the variation in the DESI.

Ukraine is absolutely not inferior in its potential to the mentioned countries, however, unfortunately, it does not take part in the ranking of countries according to the DESI for the next reasons:

- limited official statistics. In contrast to European practice (Eurostat.eu), the State Statistics Service of Ukraine has been monitoring the parameters of digitalization of the country’s economy relatively recently (since 2017, and in most cases even since 2019);

- update in 2020 by the State Statistics Service of Ukraine of the statistical sampling methodology in accordance with current European requirements (in particular, European Commission Regulation No. 2019/1910 of November 7, 2019 on the use of

information and communication technologies and electronic commerce). Therefore, for a number of indicators, data for 2020 is missing, since their collection and calculation of indicators of the digital transformation of the country's economy was not carried out;

– forming a statistical sample without taking into account data on the temporarily occupied territories of the Autonomous Republic of Crimea, the city of Sevastopol, parts of the Donetsk and Luhansk regions. With the beginning of the full-scale military invasion of Russia on the territory of Ukraine in early 2022, the collection of statistical data became

difficult or impossible (primarily, in the temporarily occupied territories and border regions;

– the absence of the formation of a statistical sample, necessary for the calculation of indices of the level of development of the digital economy, informatization and digitization of the country, on the basis of which global ratings of the digital transformation of the economy of countries are formed;

– the absence of the formation of a statistical sample in a regional section, which creates additional difficulties in the way of conducting a comprehensive and in-depth assessment of the development of the digital economy in the country [12].

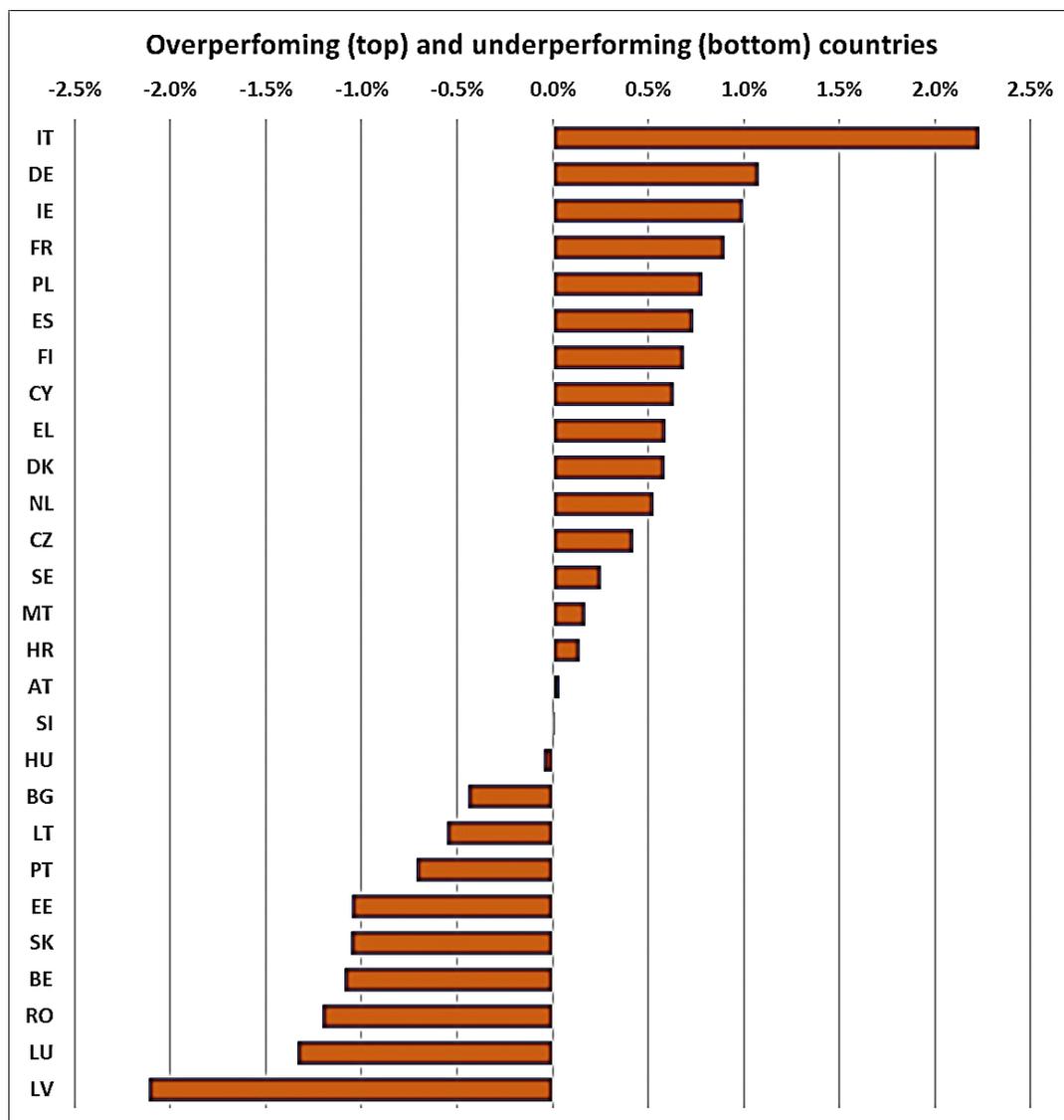


Fig. 3. Digital Economy and Society Index – Overperforming and underperforming Member States (2017 – 2022) [13]

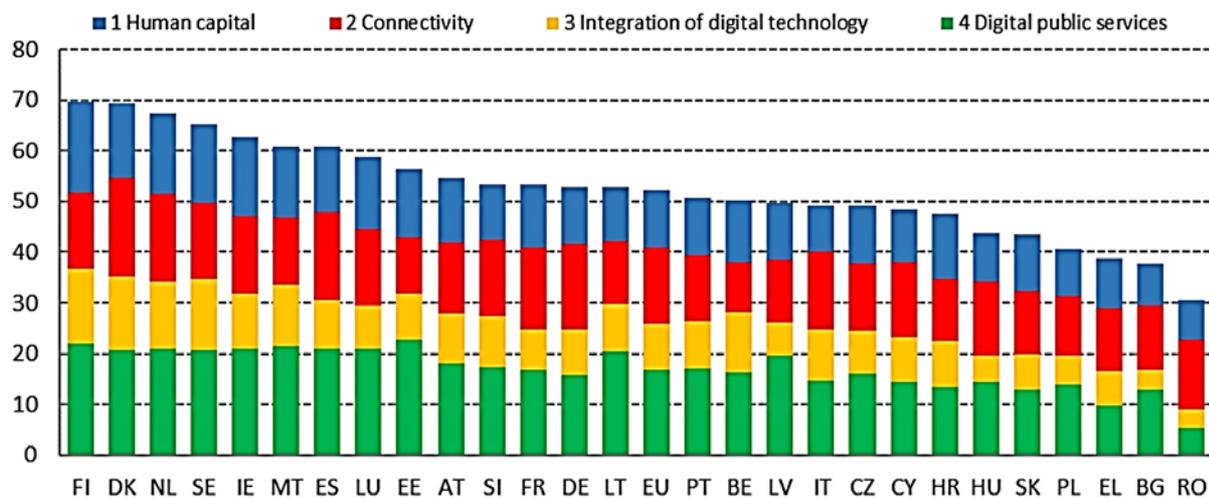


Fig. 4. Digital Economy and Society Index, 2022 [13]

However, with the acquisition by Ukraine of the political opportunity to join the European Union (officially from June 26, 2022) and the need for this to fulfil Art. 356 of the “Association Agreement between Ukraine, on the one hand, and the European Union, the European Atomic Energy Community and their member states, on the other hand”, according to which the national statistical system should be based on the “acquis” of the European Union in the field of statistics, and also with the entry into force in 2022 of the Law of Ukraine “On Electronic Communications” [14] and the Law of Ukraine “On the National Commission Carrying Out State Regulation in the Field of Electronic Communications, Radio Frequency Spectrum and Provision of Postal Services” [15], in which the need to measure the progress of digitization is determined, the situation has changed – the implementation of DESI in Ukraine is absolutely necessary. Therefore, in September 2023, by Resolution No. 989 [16] of the CMU, the Program for the Development of Official Statistics until 2028 was approved, one of the priority directions of which is (on compliance of the activities of the state statistics bodies of Ukraine with the Code of Practice of European Statistics and the Fundamental Principles of Official Statistics approved by the UN General Assembly) determined the harmonization of the national statistical system with international and European norms and standards.

For this purpose, the Decree of the CMU according to No. 774-r “On approval of the list of indicators of the Digital Economy and Society Index (DESI)” [17] defined to ensure:

- the development and approval of methodological recommendations regarding the methodology of compiling indicators of the DESI

within six months from the date of adoption of the Order by the Ministry of Digital Transformation;

- the coordination of work on the development of metadata regarding the indicators of the Index and the procedure for their collection by the State Statistics Service;

- the submission to the State Statistical Service of data and metadata by components, subcomponents and indicators of the Index by the Central bodies of executive power, which are responsible for the formation of indicators of the Index [17].

Therefore, starting from 2025, in accordance with the Program for the Development of Official Statistics until 2028, approved by the Resolution of the CMU of September 15, 2023 No. 989, business entities must report to the authorities of the State Statistical Service of Ukraine on the following components, subcomponents and indicators of the DESI (Table).

Therefore, the key elements of DESI correspond to the EU’s digital goals: secure and sustainable digital infrastructure, digital skills, digitalization of business and public services. Therefore, the introduction of DESI metrics in Ukraine:

- will make it possible to monitor the country’s progress in the direction of the digital economy, as well as to compare its own path with the digital economies of the EU;

- will help realize the state potential of digital competitiveness, as well as contribute to Ukraine’s integration into the EU’s Single Digital Market;

- identify areas where the country lags behind, and therefore adjust policies and take necessary measures to improve digital productivity;

- to attract foreign investments in the development of the country’s digital industry, etc.

List of components, sub-components and indicators of DESI [17]

Component	Sub-component	Indicator
Human capital	Availability of Internet user skills	number of people with at least basic digital skills, %
		number of people with higher basic digital skills, %
		number of people with at least basic digital content creation skills, %
	Availability of advanced skills and development	the number of specialists employed in the field of information and communication technologies, aged from 15 to 74 years, %
		the number of women specialists in the field of ICT, %
		the share of enterprises that trained employees in ICT skills in the total number of enterprises, %
		the number of graduates of higher education institutions with specialties in the field of knowledge “Information technologies” in the field of ICT, %
Connectivity	Fixed broadband take-up	the share of households using a fixed broadband connection to access the Internet, %
		the share of households using a fixed broadband connection to access the Internet, %
		the share of households with fixed broadband internet access of at least 1 Gbps
	Fixed broadband coverage	the share of households covered by high-speed broadband (NGA) Internet access networks, %
		the share of households covered by ultra-high-bandwidth (VHCN) networks, %
	Mobile broadband	the radio frequency bands harmonized and assigned for the application of 5G spectrum technology, %
		the number of settlements which have 5G coverage, %
		the share of the population that uses mobile devices to access the Internet, %
	Integration of digital technology	Digital intensity
Digital technologies for businesses		the share of enterprises using software (ERP) in the total number of enterprises, %
		the share of enterprises using social media in the total number of enterprises, %
		the share of enterprises conducting “big data” analysis in the total number of enterprises, %
		the share of enterprises purchasing cloud computing services in the total number of enterprises, %
		the share of enterprises using artificial intelligence technologies in the total number of enterprises, %
the share of enterprises sending invoices in electronic form in the total number of enterprises, %		
e-Commerce		the share of enterprises engaged in electronic trade in the total number of enterprises, %
		the volume of sold products (goods, services) of enterprises obtained from e-commerce, %
		the share of enterprises that carried out electronic trade in the total number of enterprises, %
Digital public services	e-Government	the number of users of e-government services, %
		the pre-filled forms, points (0-100)
		the state digital services for citizens, points (0-100)
		the state digital services for business, points (0-100)
		the open data, percent of the maximum score

Conclusions

Various rating indices are used at the international level to compare the dynamics of digital economy and society development between countries. Each index intends to highlight a specific aspect of these processes and uses specific metrics, data sets, and sources for acquisition. Users should be aware of these differences when interpreting the results.

However, in Ukraine, based on the interests of stakeholders regarding the socio-economic development of the country and aspirations for European integration, the acquisition of positions of digital leadership and inclusive and sustainable human-oriented development, starting from 2025, a metric for evaluating the progress of digitalization of the economy according to DESI will be introduced, which will allow track the country's digital productivity and digital competitiveness.

The implementation of the DESI metric is crucial for Ukraine's integration into the Single Digital Market of the EU. Nevertheless, several measures need to be adopted for its domestic implementation, including the development and adoption of specific by-laws that detail the organizational and legal mechanisms for the subjects involved in the DESI's implementation in Ukraine.

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ФОРМУВАННЯ МЕТРИКИ ОЦІНЮВАННЯ КОНКУРЕНТОСПРОМОЖНОСТІ УКРАЇНИ ЗА ПРОГРЕСОМ ЦИФРОВОЇ ТРАНСФОРМАЦІЇ ЕКОНОМІКИ

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В статті констатовано, що входження України до європейського цифрового ринку як одного з пріоритетних напрямів зовнішньої політики держави актуалізує проблему впровадження в національну систему статистичного спостереження глобального індексу цифрової економіки та суспільства (DESI). Акцентовано, що незважаючи на проголошений Україною курс на інтеграцію до єдиного цифрового ринку ЄС, країна до тепер не приймає участь у жодному міжнародному рейтингу з оцінювання конкурентоспроможності прогресу цифровізації економіки,

оскільки використання індексів цифрової еволюції країни не передбачається в жодному стратегічному та концептуальному документах. Встановлено, що відставання України у впровадженні нових і вдосконалених інструментів доказової бази для вимірювання цифровізації як фактора економічного зростання суттєво зужує здатність відображення у вітчизняній економіці використання та впливу на сукупну додану вартість цифрових технологій, зокрема таких як штучний інтелект та аналіз даних, Інтернет речей, 3D-друк, автоматизація та робототехніка, хмарні обчислення, мобільний широкопasmовий зв'язок 5G, блокчейн-технології в різних галузях економіки. Наголошено, що наразі в Україні на офіційному рівні затверджено лише метрику визначення Індексу цифрової трансформації регіонів України, який за своїм змістом не відповідає вимогам Євростату. Підкреслено, що імплементація у вітчизняну практику метрики визначення глобального індексу цифрової економіки та суспільства (DESI) є вкрай необхідною. Розглянуто складові елементи DESI. Здійснено оцінку готовності України до впровадження DESI. Обґрунтовано, що участь України у формуванні та наданні інформації щодо індексу DESI дозволить не тільки мати об'єктивне оцінювання щодо місця країни в загальносвітових трендах, але й мати вкрай важливу інформацією для міжнародних інвесторів щодо підтвердження Україною прихильності принципам відкритості та прозорості, взятим на себе за міжнародними зобов'язаннями щодо входження до єдиного цифрового ринку через гармонізацію своєї статистичної системи зі стандартами та практикою ЄС.

Ключові слова: цифровізація економіки, цифрова конкурентоспроможність, цифровий ринок, цифровий розвиток.

DEVELOPMENT OF A METRIC FOR ASSESSING THE COMPETITIVENESS OF UKRAINE ACCORDING TO THE PROGRESS OF THE DIGITAL TRANSFORMATION OF THE ECONOMY

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Ukraine's prioritization of entry into the European digital market as a foreign policy direction highlights the urgency of incorporating the global digital economy and society index (DESI) into the national statistical monitoring system. The article asserts that DESI introduction is a pressing issue. It was emphasized that although Ukraine has declared its integration into the EU's single digital market, the country is not currently participating in any international rating to assess the competitiveness of its digitalization progress. This is due to the absence of any strategic or conceptual documents that support the use of indices of the country's digital evolution. By not implementing new and improved tools for measuring digitalization as a factor of economic growth, Ukraine is severely limited in reflecting the use and impact of digital technologies, such as AI, data analytics, IoT, 3D print, automation and robots, Cloud, 5G mobile broadband, and blockchain, on the aggregate value added of different economic sectors. Currently, only the metric for determining the Digital Transformation Index of Ukraine's regions has been approved in Ukraine at the official level. However, this metric does not meet the requirements of

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Eurostat and therefore cannot be utilized for international comparison. It is imperative that the global Digital Economy and Society Index (DESI) metric is implemented in Ukraine's domestic practice. The constituent elements of DESI, which include connectivity, human capital, use of internet services, integration of digital technology, and digital public services, must be taken into consideration. Accordingly, an assessment was conducted to determine Ukraine's readiness for the implementation of DESI. It is justified that Ukraine's participation in the formation and presentation of information about the DESI index will allow not only to have an objective assessment of the country's place in global trends, but also to have extremely important information for international investors regarding Ukraine's confirmation of commitment to the principles of openness and transparency assumed by international obligations to enter the single digital market by harmonizing its statistical system with EU standards and practices.

Keywords: digitalization of the economy, digital competitiveness, digital market, digital development.

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