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PROBLEMS AND PROSPECTS OF THE DEVELOPMENT OF DIGITALIZATION: INTERNATIONAL AND NATIONAL LEVEL

Abstract. *The article is concerned with studying the role of digitalisation processes in the economic development of countries in the context of new modern challenges. The general scientific approaches to the definition of the concept of "digitalisation" in economic activities are highlighted. The role of modern digital technologies in achieving the competitiveness of enterprises, industries, and national economies, as well as intensifying business processes in the modern global environment is considered. It is emphasised that digital transformation takes place in various areas and directions, which allows entities of different levels of economic activity to successfully adapt to new challenges. It is found that the digital economy is not a separate economic unit at all, but a new economic model based on radically different technical and technological methods and social principles. The main directions of development of modern digital technologies in the world economy are demonstrated. An analysis of dynamic changes in the international ranking positions of Ukraine according to the indices of global and digital competitiveness is carried out. Based on a study of modern digitalisation processes in our country, it is proved that the IT industry is one of the leading sectors of the national economy. An analysis of exports of the domestic IT industry is carried out; the impact of exports of computer services and individual product groups on Ukraine's GDP is estimated. As a result, it was found that the export of computer services has a strong impact on GDP. The priorities and general principles of ensuring the digitalisation of Ukraine's economy are outlined, and the role of digitalisation in ensuring Ukraine's economic growth is considered. The main directions of financing the digitalisation of Ukraine in accordance with the Digital Europe programme until 2027 are identified. It is emphasised that digitalisation processes are inherent in a kind of risks to which both society and business may not always be ready. The authors substantiate the guidelines for promoting the security of the main tools of the digital economy and emphasise that digital decision-making will be important for Ukraine's post-war recovery.*

Keywords: digitalisation, digital economy, innovation, information and communication technologies.

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ПРОБЛЕМИ І ПЕРСПЕКТИВИ РОЗВИТКУ ЦИФРОВІЗАЦІЇ: МІЖНАРОДНИЙ ТА НАЦІОНАЛЬНИЙ РІВЕНЬ

Анотація. Стаття присвячена вивченню ролі процесів цифровізації у економічному розвитку країн в умовах нових сучасних викликів. Виділено загальні наукові підходи до визначення поняття “цифровізація” в економічній діяльності. Розглянуто роль сучасних цифрових технологій для досягнення конкурентоспроможності підприємств, галузей, національних економік, а також активізації бізнес-процесів у сучасному світовому середовищі. Наголошено, що цифрова трансформація відбувається у різноманітних сферах та напрямках, що дозволяє суб'єктам різних рівнів господарювання успішно адаптуватися до нових викликів. З'ясовано, що цифрова економіка – це зовсім не окрема господарська одиниця, а новітня економічна модель, що побудована на кардинально інших техніко-технологічних методах та суспільних засадах. Продемонстровано основні напрями розвитку сучасних цифрових технологій у світовому господарстві. Проведено аналіз динамічних змін у міжнародних рейтингових позиціях України за індексами глобальної та цифрової конкурентоспроможності. Доведено, що ІТ-індустрія є однією з провідних галузей вітчизняної економіки на основі дослідження сучасних процесів цифровізації в нашій країні. Проведено аналіз експорту вітчизняної ІТ-галузі, здійснено оцінювання впливу експорту комп'ютерних послуг та окремих товарних груп на ВВП України. В результаті встановлено, що експорт комп'ютерних послуг має сильний вплив на ВВП. Окреслено пріоритети та загальні принципи забезпечення цифровізації економіки України, розглянуто роль цифровізації у забезпеченні економічного зростання України. Виявлено основні напрями фінансування цифровізації України відповідно до програми “Цифрова Європа” до 2027 року. Наголошено, що процесам цифровізації притаманний рід ризиків, до яких можуть бути не завжди готовими і суспільство, і бізнес. Обґрунтовано орієнтири сприяння безпеці основних інструментів цифрової економіки та наголошено, що прийняття цифрових рішень буде важливим для післявоєнного відновлення України.

Ключові слова: цифровізація, цифрова економіка, інновації, інформаційно-комунікаційні технології.

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Formulation of the problem. The rapid pace of the development of science and technologies and technological progress have contributed to the emergence and rapid spread of the latest information and communication technologies in various societies. This phenomenon is now known as digitalisation. Economies of many countries are constantly looking for the most effective ways to apply the modern achievements of the digitalisation of society to ensure growth in various areas. For Ukraine, an important

strategic goal is the gradual development of the digital economy, which shows signs of growth in the economic efficiency of business entities, taking into account the use of modern achievements in the field of digitalisation of the society.

Analysis of recent researches and publications. The processes of digitalisation and their role in the economic development of countries and in the life of society are the subject of scientific research by many scholars. For example, the theoretical foundations of

the emergence and formation of the digital economy and digital business are studied by S. Koliadenko, O. Kulchytskyi, Yu. Nikitina, M. Novytska, and I. Strutynska. The role of digitalisation is considered from different scientific approaches: as a factor of increasing competitiveness by V. Bondarchuk, Yu. Kotelnikova, K. Puhachevska; as an opportunity for effective enterprise management by M. Vereskun, S. Verstiuk, V. Kolosok, E. Kolosok, V. Pilinskyi; as a means of transforming the Ukrainian economy by L. Korzun, S. Tulchynska. The development of the digital economy, in particular, the prerequisites and stages of its formation in the modern conditions are studied by S. Koliadenko, A. Krupianyk, and M. Rudenko. Studies on the impact of digitalisation at the level of international processes are also relevant today; the research in the area is conducted by M. Savchenko, A. Samoilenko, K. Sichkarenko, O. Kovaleva, and A. Kozachyshyn.

Setting objectives. The article is aimed at assessing the role of digitalization processes for the economic development of countries in the context of new modern challenges.

Presentation of the main research material. Today, digitalisation as a concept regarding economic activities demonstrates a number of interpretations, and accordingly, the essence of the term is interpreted by different scientific approaches from different positions. There are such concepts as "information economy", "digital economy", "Internet economy", and "electronic economy". However, the concept of the digital economy covers those sectors of economic activity that are based on the use of a set of modern digital technologies.

One of the common approaches is to interpret the concept of "digitalisation" as a synthetic category, which in this aspect means a set of social and economic aspects based on the processes of using a set of digital technologies. Such processes include new navigation capabilities (autonomous vehicles driven by autopilot), automation of production processes (construction of industrial facilities with a minimum of manual labour), and new principles of labour market organisation (self-employed persons, freelancing as a phenomenon in the labour market). If we focus on world trade, we can state that trade in services and in intellectual property rights has almost completely moved to the digital sphere [1, p. 108].

The competitiveness of the economy is directly determined by the specific features of the development of the digital sector, since leadership in the digital sphere contributes to an increase in competitive positions, while a lag in data acquisition and processing, and unskilled use of digital resources leads to a loss of market positions. Digital dependence can also lead to a lag in economic development between countries. There are four criteria for analysing the digital economy: the employment-related criterion; spatial, technological, and economic criteria.

It has already been proven that digital technologies are driving the growth and scientific and technological development of the international economy as a whole. The active introduction of modern digital technologies

helps to ensure the competitiveness of enterprises, industries, and the national economy, to create real opportunities for intensifying business processes in terms of connecting to digital global value chains, to create completely new markets and separate niches, and to gradually bring new digital products to the international level. Digitalisation cannot take place simultaneously in different countries, so there is a corresponding gap in the levels of digitalisation of national economies, which contributes to digital inequality and increased economic dependence of some countries on others. All factors are important for the digital transformation of the economy, including politics, regulatory frameworks, traditions and culture, level of economic development, education, and the scientific and technological base.

Understanding the new promising changes, governments are preparing for the development of the digital economy by using its advantages to provide adequate responses to the main challenges of our time, including reducing unemployment, overcoming poverty, providing security, and environmental protection. Modern digital strategies in the national dimension are becoming comprehensive, addressing the establishment of innovative enterprises or technology companies, growth in economic employment, and the formation of an effective public sector. The general list of measures taken by states to ensure the development of the digital economy includes the following: developing infrastructure as the foundation for new business models and scientific and social communities; overcoming barriers to the development of the digital economy; increasing the level of digital skills among professionals; ensuring the reliability and security of digital infrastructure. The digital economy entails the need to develop the electronic industry on an innovative basis in two key areas: the electronic industry (production of microchips, computer equipment, telecommunications devices, and consumer electronics) and companies that offer services in the digital sphere and use digital tools for data production, storage, and management.

The digital economy involves the digital transformation of all spheres of life, providing them with significant economic and social benefits, which opens up new prospects for the state, society and citizens. The core of the digital economy is the sector of production of digital goods and services related to digital technologies. Modern national digital strategies address the issues of economic development, creation of innovative enterprises, increase in employment, and formation of an effective public sector [2].

Digitalisation takes place in different areas and at different levels. For example, the digital transformation of public administration is mainly carried out through the use of electronic communication channels to reduce transaction costs. The digitalisation of the real economy strengthens the competitive position of companies by increasing labour productivity, management efficiency, automating production processes, and enhancing the investment attractiveness of facilities. The digitalisation of company management and decision-making processes helps to

reduce administrative staff costs and improve management efficiency. The benefits of digitalisation for society are undeniable, as the users of digital products and services are the population that can access high-speed Internet sources, making life more comfortable and convenient, i.e., meeting modern requirements [3, p. 64].

The concept of digitalisation of international economic relations should be understood as a full-fledged qualitative change in the information space where communication between participants in international relations takes place. The development of new formats of communication and information exchange allows for a new way of organising the implementation of trade agreements. Digital technologies have made it possible to start a business, and various individuals, including individual entrepreneurs, have acquired such opportunities. Digitalisation has helped to create a framework for qualitative analysis of market trends and structure, as the large amounts of market data generated by various devices make it possible to analyse international processes in depth and in a meaningful way. An important factor influencing the development of the digital economy is the growing number of people who have access to the achievements of the digital economy [4].

In today's international environment, companies from the digital sector are becoming leaders and points of economic growth, contributing to the provision of digital resources to the economy. At the beginning of the 20th century, powerful oil, metallurgical, machine-building and mining companies were the leading drivers of international economic relations, but today, representatives of the digital economy sector are among the leading companies. For example, Apple, the electronics and information technology company, has a capitalisation of \$577.4 billion; Google, the company dealing with Internet services, applications, and YouTube video hosting among others, shows the result of \$547.9 billion; the software company Microsoft,

\$443 billion; the online retailer Amazon, \$360 billion, etc. [2].

We understand that the digital economy is not a separate business unit at all, but a new economic model based on fundamentally different technical and technological methods and social principles. We are aware that the process of digitalisation of the economy is taking place horizontally across sectors of the national economy, mainly energy, industry, construction, transport, communications, agriculture, education, healthcare, etc.

Currently, researchers identify several key areas of digital development: artificial intelligence and machine learning; identification technologies; large databases; blockchain and cryptocurrencies; augmented and virtual reality; the Internet of things, robotics and cyber systems; computer vision and machine sensing; neural networks; cybersecurity; additive methods based on 3D printers; and cloud technologies.

In the current environment, the digital economy is a factor of economic strength and a stable source of tax revenues, as it is virtually independent of physical assets and less dependent than industry or agriculture. The resilience and power of the digital sector is clearly evident in times of crisis. That is, after the beginning of the full-scale invasion, the domestic IT industry proved to be the most stable economic sector of the economy, practically the only industry whose exports grew even during 2022.

A study by the Swiss business school IMD shows that Ukraine ranked 58th out of 63 in the overall digital competitiveness ranking, showing a two-position rise. This study is based on three areas: knowledge, technology, and readiness for the future. In total, the study uses 50 criteria, most of which, i.e. 30, are based on statistical data, and 20 are formed based on the results of surveys. According to the report, over the year, our country has shown improvement in the category of knowledge (from 45th to 39th place) and technology (from 62nd to 61st), while the indicators of readiness for the future have remained at the same level [6].

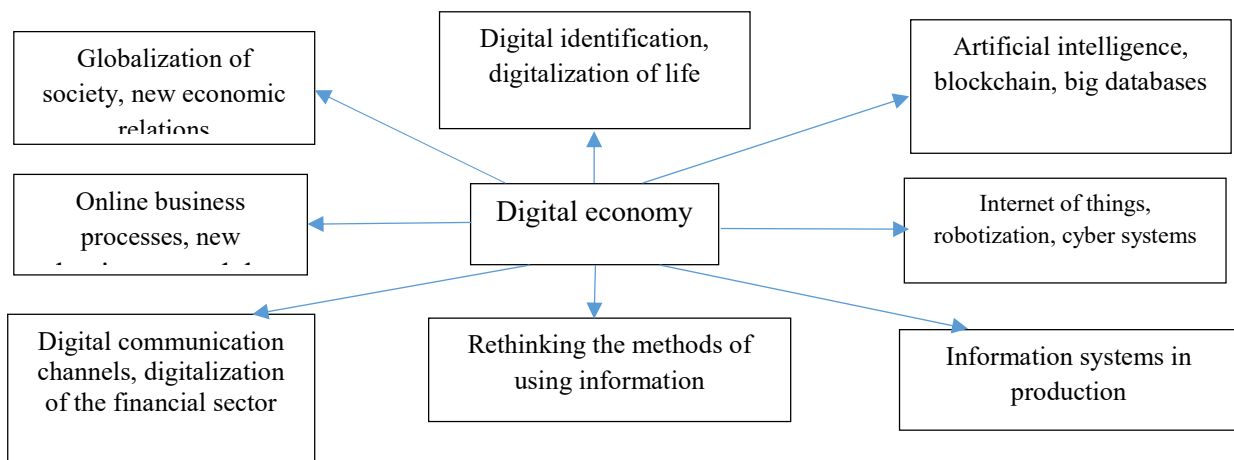


Fig. 1. Characteristics of the digital economy

Source: [5]



Fig. 2. Components of the overall digital competitiveness rating for Ukraine

Table 1

Indicators for assessing the impact of exports of computer services and certain product groups on Ukraine's GDP

	GDP, millions of US dollars	Export of computer services, millions of US dollars	Export of food products, millions of US dollars	Export of industrial products, millions of US dollars	Export of machinery, equipment and vehicles, millions of US dollars
2014	133504	2042	16670	704	5432
2015	91031	2105	14478	503	3339
2016	93356	2310	15250	463	2748
2017	112091	2760	17739	575	2862
2018	130891	3473	18594	649	3002
2019	153883	4331	22123	697	3426
2020	156618	5181	22161	722	3390
2021	199766	7107	27687	946	2819
2022	160503	7521	23380	569	2281

Source: [7]

Table 2

Correlation of the studied indicators with GDP

Export of computer services, millions of US dollars	Export of food products, millions of US dollars	Export of industrial products, millions of US dollars	Export of machinery, equipment and vehicles, millions of US dollars
0,86	0,97	0,88	-0,09

Let us consider the impact of computer services exports on the indicator characterizing economic growth in Ukraine, i.e. gross domestic product, and compare it with exports of certain product groups (food products; industrial products; machinery, equipment and vehicles) to provide a more visual view. For this purpose, we used the Python programming language with the scikit-learn machine learning library.

First, we performed a correlation analysis between the input indicators and GDP. The results are presented in the form of correlation coefficients in Table 2. The table shows that exports of food products (0.97), exports of industrial products (0.88) and exports of computer services (0.86) have the highest correlation with GDP. All three have coefficients close to one, indicating a high correlation. On the other hand, exports of machinery, equipment and vehicles have a

low correlation coefficient (-0.09), indicating no correlation. However, correlation alone is not a clear indicator of the impact of an indicator on GDP, so a deeper analysis is needed.

Next, we performed a regression analysis between the indicators and GDP. In this analysis, the indicators are used as inputs to a linear regression mathematical model, and GDP is used as the output. During the analysis, the model was trained to predict the value of GDP based on the indicators by building a linear regression and calculating the coefficients of influence of each indicator.

Now let us analyse the linear regression coefficients. The coefficients of this mathematical model clearly reflect the impact of each indicator on GDP. The results of the regression analysis are shown in Table 3.

Table 3

Коефіцієнти впливу показників, отримані з регресійного аналізу

Export of computer services, millions of US dollars	Export of food products, millions of US dollars	Export of industrial products, millions of US dollars	Export of machinery, equipment and vehicles, millions of US dollars
0,29	0,62	0,19	0,22

Table 4

Key areas of funding for Ukraine's digitalisation

Area	Amount of funding	Characteristics of the area
High-performance computing	2,2 billion euros	Projects that process large amounts of data to make decisions in the economy, healthcare, or defence industry are eligible.
Artificial intelligence, data and cloud services	2,1 billion euros	Projects that produce artificial intelligence-based products to facilitate the functioning of companies, government or research institutions are eligible.
Digital skills	580 million euros	Projects that provide opportunities to acquire the latest skills in the field of information technology are eligible.
Use of digital technologies in the economy and society	1,1 billion euros	Projects that introduce digitalisation in the areas of business or e-government, healthcare, environment, education and culture, and Smart City technologies are eligible.

The table shows that the highest coefficient of influence (0.62) corresponds to exports of food products. This indicator differs significantly from the other coefficients and indicates a high impact of exports of food products on GDP. As for the other indicators, their coefficients are close to each other and have low values (~0.2).

Summarising the results of both analyses, the following can be stated. Exports of food products have the strongest impact on GDP according to both methods. The second place is shared by exports of computer services and exports of industrial products, as they have high correlation values. Exports of machinery, equipment and vehicles have the least impact due to low correlation and regression coefficient values. Therefore, in general, we can bring attention to a strong impact of exports of computer services on GDP, and further development of the industry will contribute to economic growth and competitiveness of the country.

Today, Ukraine has joined the Digital Europe 2027 programme, which provides significant funding to ensure the digitalisation of EU member states in the relevant areas. There are four priorities for our country to receive funding [8]:

The programme also includes Cybersecurity, but this area is not yet open to non-EU countries. The common fund of the programme "Digital Europe" is set at 7.5 billion euros. Almost 6 billion euros are allocated to finance projects in areas that are available to Ukraine, and full participation in the programme requires periodic payments. However, the EU has exempted our country from paying them in 2021-2022 and provided a large 95% discount on financial contributions in 2023-2027.

A set of risks that society and business may not always be prepared for are inherent in digitalisation. Advances in automation and the use of robotics may

have consequences in terms of labour market disruption and income inequality. The so-called digital divide may widen due to a lack of access to digital technologies. Other challenges include security issues and violations of privacy principles, deepening social exclusion, and the removal of ethical boundaries.

For the successful implementation of digital solutions, it is necessary to take into account a number of challenges and dangers that can be grouped into three groups: social and economic, technical and organisational, and natural, which stem from the specifics of using the achievements of scientific and technological progress in the real economy. Under these conditions, there is a need to ensure the security of the main tools of the digital economy, such as the protection of electronic signatures, payments, tokens, sim cards, online services, information in electronic clouds and databases. This includes the need to develop cryptography and identity authentication technologies, protection systems for electronic documents circulation, information transmission channels and networks, server protection, security of commercial and public electronic platforms, etc.

Ukraine's post-war reconstruction is expected to be one of the largest in Europe, and the scope of the reconstruction tasks and the possibilities of using modern technologies create unique challenges and form a favourable basis for creative digital solutions to address them.

Conclusions and prospects for further research in the area. The spread of information and communication technologies and digital solutions in various spheres of life is gaining momentum internationally, and they are being intensively used in the economic sector and contribute to both economic growth and the development of society as a whole.

The economies of different countries are constantly looking for the most effective ways to apply the

modern achievements of the digitalisation of society to ensure growth in various areas. For Ukraine, an important strategic goal is the gradual development of the digital economy, which shows signs of growth in the economic efficiency of business entities, taking into account the use of modern achievements in the digitalisation of society.

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