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Article

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Economic Forum

Provided in Cooperation with:

Lutsk National Technical University

Suggested Citation: Liutak, Olena; Baula, Olena (2024) : Optimising the focus of digital technologies in the context of implementing a sustainable development strategy for the international business environment, Economic Forum, ISSN 2415-8224, Lutsk National Technical University, Lutsk, Ukraine, Vol. 14, Iss. 3, pp. 8-20,
<https://doi.org/10.62763/ef/3.2024.08>

This Version is available at:

<https://hdl.handle.net/10419/318690>

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Optimising the focus of digital technologies in the context of implementing a sustainable development strategy for the international business environment

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Abstract. The active spread of digital technologies shapes the pace of dynamics and trends in the development of the international business environment: on the one hand, the flexibility of the business sphere is increasing, on the other hand, new challenges are emerging for the stability of the business environment, the competitiveness of traditional sectors of the economy, including economic and information security. The purpose of the article was to study the digital innovation activity of the business environment by comparing and modelling the impact of independent variables on the gross domestic product of the EU and Ukraine. The methodological basis used in the study was the tools of economic-mathematical and correlation analysis, comparative, quantitative, tabular analysis and synthesis, SWOT analysis. The article conducted a comparative analysis of the value of indicators of international rankings reflecting the level of digital development of the Visegrad countries and Ukraine for 2017-2023; assesses the digital and technological components of the overall international competitiveness ranking of Ukraine, Poland, the Czech Republic, Hungary and Slovakia. By using econometric analysis, the use of a linear dependence function that described in detail the dynamics of economic development was substantiated; a multifactorial economic and mathematical model was built to determine the strength of the relationship between the indicators of digital and innovative business activity in Ukraine and the main macroeconomic indicator is GDP; a SWOT analysis of the impact of digitalisation on the achievement of global sustainable development goals by the international business environment was carried out; the directions of the new focus of digital technologies in the context of real-world development were substantiated. The practical significance of the results lies in the fact that the main scientific provisions have been brought to the level of methodological developments that can be used by: business entities – when choosing to use digital technologies, increasing their own competitiveness in the international arena; entities generating innovations – when developing digital innovations, developing innovation hubs; government authorities – when developing a regulatory framework for the implementation of digital innovations to achieve global sustainable development goals, development of digital infrastructure, and regulation of investment operations

Keywords: global sustainable development goals; business entities; digital innovation activity; digitalisation; Industry 4.0; Industry 5.0

Suggested Citation:

Liutak, O., & Baula, O. (2024). Optimising the focus of digital technologies in the context of implementing a sustainable development strategy for the international business environment. *Economic Forum*, 14(3), 8-20. doi: 10.62763/ef/3.2024.08.



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Introduction

Much of the current research, publications, and analytical materials are devoted to the digital transformation of the global economy, but a number of aspects require more thorough analysis. In particular, the areas of restructuring and modernisation of institutions that ensure the digital transformation of the global economy (regulatory framework for digital production and digital markets, training of personnel with a high level of digital competencies), as well as the conditions and factors for the effective development of digital technologies, and the creation of an appropriate technical infrastructure, the formation of which requires both effort and investment, require theoretical understanding and applied analysis. Of particular relevance is the consideration of aspects of the digital transformation of the international business environment through the prism of achieving global development goals based on the principles of sustainability.

Optimisation of digital technologies in the context of sustainable development of international business is a key task, as digital transformation increases business efficiency, reduces emissions and optimises resources. In 2020-2023 saw a significant transformation of the global economy, with a focus on achieving sustainable development goals through digitalisation. International businesses have been actively adopting digital technologies to increase competitiveness and sustainable growth, so digitalisation is covering all aspects of business, contributing to the creation of new models and innovations. The number of studies assessing the impact of digitalisation on economic growth increased in 2019-2023, and the authors also considered the impact of digital technologies on various aspects of economic growth, especially in the context of sustainable growth and development.

The authors of P. Jones & M. Wynn (2021) determined that the increasing attractiveness of digital technologies and the growing trend of their use in shaping trends in sustainable economic development, which is the basis for further global development of society as a whole. Their research is based on the inductive method, which is based on the analysis and evaluation of publicly available company reports. The result of the researchers' work was the formation of six areas of sustainable development.

G. Secundo *et al.* (2022) noted that the international business environment has suffered significant losses from the COVID-19 pandemic, which has led to a significant transformation of the model of competitive behaviour of corporations. In 2022-2023, companies continue to face and respond adequately to external stakeholder pressure. One of the current trends is the focus on employee health and the environment. As a result, more and more companies are becoming open and voluntarily commit to providing information on their strategies.

Particularly noteworthy are the studies of such scholars as T. Shtal & K. Pliekhanova (2023), who analysed in detail the Digital Competitiveness Index, Ukraine's place

in the overall index, and assessed the importance of its components, such as the level of knowledge, technology and readiness for the future, including sub-factors, which made it possible to identify the strengths and weaknesses of Ukraine's digitalisation. Ya. Stolyarchuk *et al.* (2022) emphasised that Ukrainian innovative entrepreneurship is based on key processes for the innovative development of the global economic system, based on the use of the principles and trends of such a phenomenon as Industry 4.0. As a result, the systemic development of innovative entrepreneurship implies, on the one hand, the maximum mobilisation and use of the national scientific and technical potential, in particular through its further integration into European innovation networks. I. Kryvyovyzuk *et al.* (2019) focused on the strategy of business environment development through strategic decisions made by managers of transnational companies (TNCs) and affecting the efficiency of their activities. V.M. Kudryavtsev (2022) in his research focused on identifying key trends in the impact of digitalisation on the economic, social and environmental components as a guarantee of sustainable and resilient economic growth at all levels.

A separate area of research is devoted to increasing energy efficiency through the use of digital technologies to monitor and manage energy consumption in manufacturing and other industries aimed at reducing emissions and increasing sustainability, among which the publications of F.P. Appio *et al.* (2021) are worth highlighting. L. Xu *et al.* (2023) focused on smart resource management using the Internet of Things and data analytics to effectively manage resources such as water, electricity, and raw materials.

F. Ciulli & A. Kolk (2023) proposed a new approach to 'augmenting' the (potential) role of certain new technologies in addressing specific sustainability challenges. Their examples illustrate the relevance of this approach for multinational corporations and for the development of innovative research areas that expand the existing understanding of digital globalisation.

Among the modern directions of optimising the focus of digital technologies in the context of sustainable development and activation of the business environment are digital logistics and e-commerce, which are reflected in the research of N.E. Krasnostanova & T.A. Yakymenko (2023). Another area of research that represents the focus of digital technologies on the implementation of a sustainable development strategy in the business environment is the transformation of the fourth industrial revolution. Industry 4.0 tries to combine the physical aspects of the world of real things with information prototypes that are being formed as structural elements of Industry 5.0. The new paradigm is based on the principles of the official functioning of Artificial Intelligence both in everyday life of society and in optimising business flows by global economic entities

and implementing the Internet of Things. In support of these theses, R.A. Mouha (2021) noted that the Internet of Things, on the one hand, is designed to provide both social and economic benefits for developing countries. On the other hand, it can focus on the following key areas: healthcare, environmental management and audit, environmental management, agriculture, water quality and availability. These postulates are the basis of the UN Sustainable Development Goals, which means that the IoT will serve as a promising tool for achieving them (United Nations. Ukraine, 2024). In addition, it is worth noting that there are also challenges associated with the IoT, as potential threats to society and the economy need to be taken into account and addressed in the context of preventive measures.

All of this requires an in-depth analysis of the digital and innovative activity of business entities, identification of trends in the development of the business environment and substantiation of the impact of independent factors representing the digitalisation sector on the GDP of Ukraine and a number of EU countries from the perspective of using econometric modelling, which is the main purpose of this study. This will help to identify the potential of digitalisation of the economy in the context of ensuring economic growth through digital tools, as well as to substantiate the priority vectors of the international business environment to achieve global sustainable development goals.

Materials and Methods

The study used methods of scientific knowledge that contributed to obtaining objective results and conclusions, including the empirical method, which allowed collecting relevant data and analysing specific observations; the theoretical method, which is based on the analysis and consideration of existing theories, concepts and models to formulate new hypotheses and identify areas for further research; the analytical method allowed breaking down complex problems into smaller parts for better understanding and revealing the essence of the digitalisation phenomenon. The synthesis method and SWOT analysis were also used to determine the impact of digitalisation on the Sustainable Development Goals, as well as comparative, quantitative and tabular analysis methods. A linear equation of dependence of the vector of the digital and innovation component of international competitiveness was used to reflect the relationship between the amount of innovation expenditures and direct investment in the country's economy, which has the following form:

$$Y = a_1X_1 + a_2X_2 + a_3X_3 + a_4X_4 + u. \quad (1)$$

In substantiating the indicators of adequacy of the multivariate analysis equation, the Fisher's criterion was calculated using the formula:

$$F_{calc} = \frac{R^2}{1-R^2} * \frac{n-m-1}{m}. \quad (2)$$

When using software products for bivariate analysis, the results are presented in the form of linear, logarithmic, polynomial, power, and exponential equations.

The main data used for the analysis were statistical materials of the State Statistics Service of Ukraine (2019; 2020), in particular, the following indicators were used to build a multivariate regression equation: the number of enterprises with access to the Internet, the share of enterprises using social media in the total number of enterprises, the share of enterprises purchasing cloud computing services in the total number of enterprises, the dynamics of GDP knowledge intensity, the number of innovatively active industrial enterprises, the share of enterprises that in assessing the dynamics of international rankings, including the World Digital Competitiveness Ranking, the Global Connectivity Index, the Digital Economy and Society Index, and the Global Competitiveness Index, the analytical materials of the International Institute for Management Development (World Digital Competitiveness Ranking, 2018-2023), GSM Association, European Commission, World Economic Forum (The Global Competitiveness Report, 2017-2021) were used as a basis.

The collected and processed statistical data made it possible to describe the state, structure, and dynamics of the relevant indicators of digital innovation in Ukraine and the Visegrad countries, as well as to diagnose the level of correlation with the factors determining international competitiveness.

Results and Discussion

The modernisation of the global economy to ensure its sustainable development trajectory necessitates the generation of effective digital technologies based on innovative products. The main requirement for the formation and development of digitalisation processes is their versatility and inclusiveness.

Efficiently functioning digital technologies have an impact on the economic, environmental and social development of the business environment, namely on institutional micro-units, national economies at the macro level, and contribute to the development of global business. The formation of digital technologies and the creation of effective mechanisms for their functioning are urgent tasks not only in the practical plane, but also in the fundamental aspect of modern science. Digitalisation without fundamental changes in modern business models will intensify environmental threats and make sustainable development impossible. That is why it is desirable to promote the development of digital transformations in accordance with approaches based on environmental restoration and ensuring the goals of global sustainable development based on the latest technologies, science and innovation.

The increased use of digital technologies in the international business environment is contributing to the transformation of the nature of global competition, which is reflected in the blurring of traditional industry

boundaries and intensification of inter-industry competition; and the increased expectations of consumers to receive personalised, high-quality products in a relatively short period of time. Companies that ignore the current challenges of digitalisation are losing their international competitiveness due to the redistribution of value added in favour of digital companies. Digitalisation of business models is leading to the destruction of traditional industries. The labour market is undergoing a significant transformation, as more and more people leave their full-time jobs to work from home or take up temporary short-term positions as independent contractors. The importance of the digital transformation of the business environment is reflected in fundamental changes in investment processes. The integration of new technologies can change the nature of international activities of MNCs and the impact of foreign branches on host countries.

Sustainable development takes place in the context of accelerating scientific, technological and social progress. That is why rapid and adequate changes in the institutional environment in general and the formation of a sustainable and high-quality international business environment are necessary. In the report by T.V. Pysarenko (2023), the main results of the state of scientific and scientific and technical activities were identified based on the data of the State Statistics Service of Ukraine. The formation of a productive institutional environment will guarantee a reduction in transaction costs, and an effective institutional infrastructure will be provided by various programmes for the development of the digital society.

The transformations caused by the spread of digital technologies are changing the rules and norms established in the industrial economy. The popularisation of such digital phenomena as blockchain, social media and digital platforms necessitates the search for new principles of interaction in international business. That is why timely digital technologies create significant opportunities for increasing economic and social efficiency for the business environment, as well as the foundation for implementing the principles of the sustainable development concept (Official website of Diia, 2021).

The introduction of innovation and information approaches can provide a higher level of efficiency and productivity with less resource consumption. However, some authors argue that “there is a synergy between Industry 4.0 and sustainable production, considering the former as a means of developing environmentally friendly products and processes that will change production and consumption patterns” (Kudryavtsev, 2022).

Some researchers note that digitalisation is associated with a significant degree of uncertainty, forcing businesses to introduce organisational changes and take into account numerous interconnections in their decision-making processes. A significant number of scientific studies on sustainability and digitalisation point to the complexity of their combined study. This is due to the fact that these processes do not necessarily overlap

and may have different goals: sustainable development clearly involves the transformation of the industry structure, while digitalisation is a progressive technological trend without necessarily being linked to the sustainable development goals (Kudryavtsev, 2022).

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At the micro level, i.e. the firm level, the relationship between digital transformation and sustainability has been studied by scholars such as A.-M. Gomez-Trujillo & M.A. Gonzalez-Perez (2021). They focused on the fact that digital transformation is a driving force in ensuring sustainability. In order to take into account the significant changes brought about by the digital revolution, it is necessary to expand its digital capabilities and balance social, economic and environmental impacts. This trend in research has been deepened by the following scholars F. Ciulli & A. Kolk (2023), who focused on the advantages and disadvantages of digitalisation in the context of its impact on multinational corporations and taking into account the sustainable development of the business environment of the identified international market players.

The results of the research by V. Varriale *et al.* (2024) showed that there is a close correlation between the sustainable development goals and the introduction of artificial intelligence, geospatial technologies, blockchain, the Internet of Things, and 3D printing into the business strategy of enterprises. The authors prove that the technological choice has a high level of influence on the implementation of digital technologies aimed at achieving the SDGs.

As of 2024, the scientific literature is dominated by opinions on considering digital technologies as a paradigm shift in production that combines new technologies designed to maximise productivity with efficient use of resources (Negroponte, 1995); integration of sustainability and digitalisation (Bag *et al.*, 2021); and orientation of industrial evolution towards digitalisation as a means of ensuring sustainable development (Appio *et al.*, 2021).

The 21st century is characterised by the international business environment's focus on the introduction of digital technologies, which is not accidental, but due to the growing expectations of consumers, the network nature of production at the international level, and the difficult financial and economic situation in the global

environment. It is advisable to address these issues with the help of digital technologies, which have proven to be effective over time. Digital technologies are the basis for the emergence and implementation of innovative services and products. Businesses and citizens are already interacting in the modern digital world, which is most convenient for them.

It is worth analysing the state of digitalisation of the economy in the international dimension. International organisations such as the United Nations, the Group of Twenty (G20), the OECD, the European Commission, the World Bank are actively analysing the development of the digital economy. The IMD World Digital Competitiveness Ranking (2019-2023) is informative. This 2023 ranking classifies 64 countries according to the level of their perception and use of digital technologies as a factor in transforming the state's relations with the population and business, changes in business models of companies and society in general. According to the methodology, countries are ranked by their digital competitiveness based on three groups of factors, which include 3 sub-factors each (51 criteria in total, with a maximum value of 100.0): the pace of development of scientific potential, availability of financial capital and technological conditions, quality of the regulatory framework, and the ability of businesses to adapt to a changing environment. The values of the World Digital Competitiveness Ranking 2023 (2024) indicated that national digital competitiveness is the result of investment in education to provide the skills required by the modern labour market.

More technologically digital is the GSMA Mobile Connectivity Index (2022), which brings together the mobile ecosystem to identify needs, develop and implement innovations that are the basis for creating a favourable business environment and driving social change. The GSMA operates in three main areas: Connecting for Good, Industry Services, and Solutions and Outreach. The GSMA Mobile Connectivity Index analyses the performance of 170 countries (99% of the world's population) and provides a summary assessment of the key drivers of mobile internet adoption: infrastructure, accessibility, consumer readiness, content and services in the context of their development in terms of market supply and demand, user experience and growth potential.

The Digital Economy and Society Index (2023), developed by the European Commission and assessing only the countries of the European Union, allows to assess the digital competitiveness of each EU member state and determine which countries need investment or measures to improve their digital development. This index is a composite index that aggregates a set of relevant indicators structured around the dimensions of connectivity, human capital, internet use, digital integration and digital public services. This index has been calculated since 2014, and until 2017, DESI scores ranged from 0 to 1, and since 2018, it has been calculated on a percentage scale (the higher the value, the better the country's performance). Since Ukraine is not a member of the EU, it is not indexed by this indicator. The expediency of considering the dynamics of the Digital Economy and Society Index (2023) is due to the fact that the objects of this study, in addition to Ukraine, are the countries of the Visegrad Group that are members of the EU.

A number of other indexes are used in the international business environment, which in one way or another determine the qualitative and quantitative indicators of the level of digitalisation of the international business environment: The Broadband Internet Access Index, the Digital Intelligence Index, the Cisco Digital Readiness Index, the Ease of Doing Digital Business Index. Methods for calculating these rankings vary. However, a set of quantitative sub-indices reflect the level of perception of digital technologies.

In order to reflect the relationship between the level of digitalisation of a country's economy and its level of international competitiveness, it is advisable to assess the country-specific value of the Global Competitiveness Index. It is worth noting that the index is formed on the basis of 12 key indicators, which are calculated for a different number of countries, taking into account current trends (The Global Competitiveness Report, 2017-2021).

Table 1 shows the values of the ratings reflecting the level of digital development of countries for Ukraine and its neighbouring countries that are members of the Visegrad Group. This choice of countries is based on the implementation of Ukraine's European integration course and the experience of these countries to enhance these processes.

Table 1. Dynamics of international rankings reflecting the level of digital development of the Visegrad countries and Ukraine (2017-2023)

Indicator	Country	Years						
		2017	2018	2019	2020	2021	2022	2023
World ranking of digital competitiveness of countries	Poland	65.87	68.56	73.71	69.23	60.94	63.09	66.53 (39 place)
	Czech Republic	70.55	71.49	71.81	67.46	65.22	75.54	79.42 (24 place)
	Hungary	58.50	57.10	65.47	55.91	55.23	65.25	58.25 (47 place)
	Slovakia	59.28	56.54	62.62	53.26	54.20	59.64	58.31 (46 place)
	Ukraine	44.00	51.29	55.26	48.81	50.07	-	-

Table 2, Continued

Indicator	Country	Years						
		2017	2018	2019	2020	2021	2022	2023
Global Connectivity Index	Poland	73.63	76.48	76.55	77.73	78.71	80.13	-
	Czech Republic	75.05	77.21	77.74	80.68	81.33	82.27	-
	Hungary	73.53	78.82	78.38	80.22	80.96	81.66	-
	Slovakia	71.60	74.85	75.64	79.24	80.06	82.03	-
	Ukraine	57.58	65.11	63.50	67.24	67.74	65.92	-
Digital Economy and Society Index	Poland	0.43	37.7	40.7	45.0	41.0	40.5	-
	Czech Republic	0.5	45.3	47.6	50.0	47.4	49.1	-
	Hungary	0.46	40.1	43.2	45.4	41.2	43.8	-
	Slovakia	0.46	41.9	42.9	45.2	43.2	43.4	-
Global Competitiveness Index	Poland	4.59	68.2	68.9	68.8	68.6	68.9	60.48
	Czech Republic	4.77	71.2	70.9	70.9	71.0	71.1	83.48
	Hungary	4.33	64.3	65.1	65.3	65.1	65.7	59.85
	Slovakia	4.33	66.8	66.8	66.9	66.9	67.2	53.84
	Ukraine	4.11	57.0	57.0	56.8	56.0	54.8	-

Source: based on *The Global Competitiveness Report (2017-2021)*, *World Digital Competitiveness Ranking (2018-2024)*

According to global statistics, in 2020-2023, Ukraine will not be able to fully exploit the potential of digital technologies for the development of the Ukrainian economy. Compared to its Eastern European neighbours, Ukraine has the lowest scores in global rankings and indices. Moreover, even this level was ensured mainly by the high performance of such rating components as education and scientific concentration (Semenog, 2020; Shtal & Pliekhanov, 2023).

The next step was to assess the impact of the digital and technological component on the international competitiveness of the selected research objects. To accomplish this task, the econometric analysis was used to determine the dependence function that was the most correct and described economic growth taking into account independent factors. The econometric analysis was based on a study of four global indices reflecting the level of digital development of countries for 2017-2023,

as shown in Table 1. The use of the Microsoft Office Excel software allowed to identify indicators characterised by a high level of correlation.

The linear equation for the dependence of the vector of the digital and innovation component of international competitiveness (the sum of innovation costs and direct investment in the country's economy) is as follows:

$$Y = a_1X_1 + a_2X_2 + a_3X_3 + a_4X_4 + u, \quad (3)$$

where Y – vector of the innovation and digital component of international competitiveness; X_1 – the vector of the digital competitiveness index of countries; X_2 – the vector of the global connectivity index; X_3 – the vector of the digitalisation index of the economy and society; X_4 – the vector of the global competitiveness index; u – the vector of the stochastic component.

The corresponding regression equations for each of the countries under study are presented in Table 2.

Table 2. Regression equation for the dependence of the digital innovation component vector on independent variables

Country	Equations of the multivariate model
Czech Republic	$Y = 16.82 * X_1 + 172.011 * X_2 + 5.698 * X_3 + 14.39 * X_4 + 12.54$
Hungary	$Y = 18.2598 * X_1 + 0.9254 * X_2 + 3.0289 * X_3 + 6.3581 * X_4 - 1258.365$
Slovakia	$Y = 6.57423 * X_1 + 19.374 * X_2 + 18.367 * X_3 + 0.25849 * X_4 + 154.301$
Poland	$Y = 18.632 * X_1 + 28.6957 * X_2 + 26.358 * X_3 + 7.1864 * X_4 - 2.358$
Ukraine (X_3 was not taken into account due to lack of data for Ukraine)	$Y = 1.859 * X_1 + 487.320 * X_2 + 3.845 * X_4 + 14.801$

Source: calculated by the authors

Table 2 shows that the index of digital competitiveness of countries (X_1) has the greatest impact due to its high coefficient. For the Visegrad countries, along with X_1 , it is worth mentioning X_3 , which also has a positive value greater than 1. Based on the

methodology presented in previous studies (Liutak *et al.*, 2023), the model built is adequate to the statistical data and is correct for further analysis. A summary analysis of the multiple correlation coefficients is presented in Table 3.

Table 3. Validation of models based on multiple correlation coefficients

Country	Multiple correlation coefficient (<i>R</i>)	Coefficient of determination (<i>R</i> ²)	Fisher's criterion $F_{calc} = \frac{R^2}{1 - R^2} * \frac{n - m - 1}{m}$
Czech Republic	0.84716	0.71768	12.71040
Hungary	0.84582	0.71541	12.56913
Slovakia	0.95487	0.91178	51.67649
Poland	0.88514	0.78347	18.09149
Ukraine	0.79573	0.63319	8.63104

Source: calculated by the authors

The analysis of the table data shows that the models are adequate due to the fact that the calculated coefficients correspond to a normal distribution. To deepen the study, a multifactorial economic and mathematical model was built. This equation will allow to calculate

the strength of the relationship between independent indicators of digital and innovative business activity and the main resulting factor – Ukraine's GDP. The relevant initial data collected on the basis of statistical indicators are presented in Table 4.

Table 4. Empirical data for building a model of the dependence of the resultant indicator on the identified factors

Year	GDP, million UAH	Number of enterprises with access to the Internet	Share of enterprises using social media in the total number of enterprises, %	Share of the number of enterprises that purchase cloud computing services in the total number of enterprises, %	Dynamics of GDP research intensity, %	Number of innovatively active industrial enterprises, units	Share of enterprises engaged in innovations, %	Expenditures on innovations for the purchase of machinery, equipment and software, UAH million	Volumes of venture capital investment, million USD
	<i>Y</i>	<i>X</i> ₁	<i>X</i> ₂	<i>X</i> ₃	<i>X</i> ₄	<i>X</i> ₅	<i>X</i> ₆	<i>X</i> ₇	<i>X</i> ₈
2013	1522700	39254	20.8	3.7	0.70	1715	16.80	5546.3	37
2014	1586900	40111	23.1	5.2	0.60	1609	16.10	5115.3	42
2015	1988500	40747	25.7	6.8	0.55	824	17.30	11141.3	146
2016	2383200	38825	25.8	7.0	0.48	834	18.90	19829.0	80
2017	2983882	39582	26.1	7.2	0.45	759	16.20	5898.8	265
2018	3558706	43303	29.7	9.8	0.47	777	16.40	8291.3	323
2019	3974564	43785	30.1	10.3	0.43	782	16.58	10185.1	542
2020	4194102	-	- ²	- ⁴	0.41	809	17.13	8788.2	571
2021	5459574	44508	- ³	10.2	0.29	784	16.42	9325.4	832
2022	5191028	42785	29.1	9.8	0.33	734	16.08	9158.3	218

Note: ^{1,4} data collection and calculation for 2020 was not carried out in accordance with the updated approved statistical methodology, which takes into account the requirements of Commission Regulation (EU) No. 2019/1910 of 07.11.2019 on the use of ICT and e-commerce; ^{2, 3} data for 2020, 2021 were not collected and calculated in accordance with the updated approved statistical methodology, which takes into account the requirements of Commission Regulations (EU) 2019/1910 of 07.11.2019 and 2020/1030 of 15.07.2020 on the use of ICT and e-commerce (frequency of the indicator is once every two years)

Source: prepared according to State Statistics Service of Ukraine (2019; 2020), Official website of State Statistic Service of Ukraine (2024)

To accomplish this task, the indicators that indicate the quantitative and qualitative parameters of the level

of digitalisation of Ukraine's economy and its innovation capacity were used (Fig. 1).

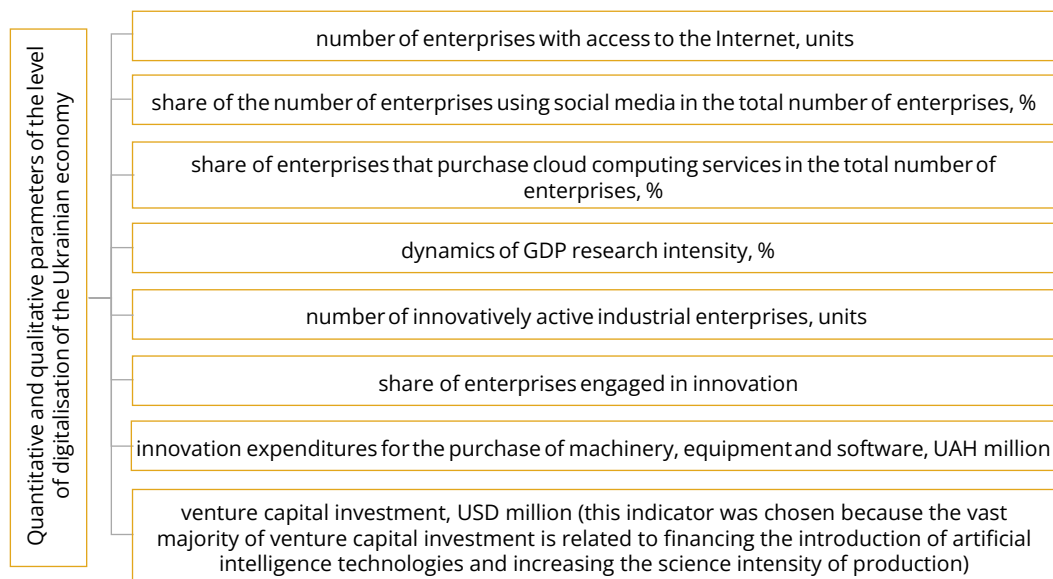


Figure 1. Quantitative and qualitative parameters of the level of digitalisation of the Ukrainian economy

Source: developed by the authors

To build the equation of the multivariate model of the dependent variable GDP (Y) on the independent indicators of the performance of digital business activity in Ukraine, software products (the Data Analysis package extension of Microsoft Excel) were used. As a result of using software products, the equation of multifactorial dependence of GDP was obtained:

$$Y = 312.5843 * X_1 + 8.2174 * X_2 + 43.5877 * X_3 + 3214.2859 * X_4 - 379.413 * X_5 + 12.73625 * X_6 + 17.356987 * X_7 + 953.57X_8 - 913321.46. \quad (4)$$

The adequacy and reliability of the obtained model was checked taking into account the two main coefficients, namely the correlation coefficient (which corresponds to the value of 0.8773) and the determination coefficient (0.7697). As can be seen from the equation, the most significant impact on the resulting indicator is made by such independent variables as:

- number of enterprises with access to the Internet;
- dynamics of GDP research intensity (%);
- venture capital investment (USD million).

The calculations revealed that the growth of these indicators will lead to an increase in the level of digitalisation and innovation of the Ukrainian economy and, as a result, GDP growth and economic well-being. In order to provide more thorough recommendations on how to use the potential of digitalisation and innovation in the business environment to increase the country's GDP growth rate, it is advisable to assess the significance of these indicators in more detail. Accordingly, the next step in the study is to build two-factor regression models (Table 5). Table 5 shows that the impact of the number of enterprises with access to the Internet on GDP is described by a power law equation, while the dynamics of GDP knowledge intensity and venture capital investment is described by a polynomial equation.

Table 5. Equation of dependence of GDP impact on digital and innovation factors

Linear equation	Logarithmic equation	Polynomial equation	Power equation	Exponential equation
Number of enterprises with access to the Internet				
$y = 125.88462x + 566447.765$ $R^2 = 0.23655$	$y = 214412.86560 \ln(x) - 54877.047$ $R^2 = 0.43255$	$y = 12.5447x^2 + 184.47712x + 254221.52$ $R^2 = 0.65578$	$y = 196553.44213 * x^{0.27987}$ $R^2 = 0.81774$	$y = 425474.845699 e^{0.00544x}$ $R^2 = 0.32547$
Dynamics of GDP research intensity, %				
$y = 130879.85474x + 6985144.418$ $R^2 = 0.42587$	$y = -8549618.31347 \ln(x) + 32541376.77381$ $R^2 = 0.82925$	$y = 6781.06511x^2 - 524687.29826x + 16544883.475$ $R^2 = 0.83458$	$y = 86654412277.34 470x^{-2.93444}$ $R^2 = 0.72441$	$y = 43566877.43318 e^{-0.04364x}$ $R^2 = 0.70544$
Venture capital investment volumes, USD million				
$y = -3225487.12144x + 33256321.513$ $R^2 = 0.85421$	$y = 95432.39326 \ln(x) - 547784.342$ $R^2 = 0.68544$	$y = 352144.74451x^2 - 744751.32244x + 214121.52$ $R^2 = 0.91244$	$y = 145478.32556 x^{3.25415}$ $R^2 = 0.82533$	$y = 13457895.12477 e^{-3.12456x}$ $R^2 = 0.74584$

Source: calculated and compiled by the authors

Characterising the values of the coefficients of determination in the models describing the level of influence of digital innovation factors on GDP, it should be noted that the largest value is $R^2 = 0.91244$, which corresponds to the indicator 'Venture capital investment'. The article analyses the conformity of the model described by the equation based on the Fisher's criterion:

$$y = 6781.06511x_2 - 524687.29826x_3 + 16544883.47557. \quad (5)$$

The formula for calculating the Fisher's criterion:

$$F_{calc} = \frac{(0.83458)^2}{1 - (0.83458)^2} * \frac{10 - 1 - 1}{1} = 18.361208. \quad (6)$$

According to the standard sample data, the tabulated value of Fisher's criterion is $F_{tab.} = 5.32$. According to the methodology, the fulfilment of the inequality $F_{sum.} > F_{tab.}$ ($18.361208 > 5.32$) indicates that the model is adequate with a 95% probability and can be used for forecasting.

According to the methodology described in previous studies by O. Liutak *et al.* (2023) and using the Excel software product 'Data Analysis', the value of the correlation coefficient – the statistical relationship between two variables, denoted by $r[x; y]$ was calculated, which is 0.8344. This indicator shows that the relationship between the relevant independent factor and GDP is direct and strong.

Thus, it is reasonable to conclude that the factor "Dynamics of GDP science intensity, %" has the most significant impact on GDP among the indicators under

consideration. The analysis showed that the processes of digitalisation, innovation and scientific technologisation have a significant impact on the optimisation of the activities of entities at all levels of the international business environment.

The global environment is actively using and implementing digital technological trends based on the global digitisation of processes, the use of new materials and new management systems. Human labour can be easily replaced by robotics, which reduces the time required to complete production operations and increases labour productivity. E-commerce is characterised by better efficiency compared to brick-and-mortar trading. Automation facilitates the production process, but along with its benefits, digitalisation also poses challenges for the international business environment. The spread of digitalisation is a generator of not only new opportunities but also significant threats for all segments of the population. Digital technologies can be disruptive, which will have a negative impact on productivity, employment and welfare in the future. These technologies may also displace workers from the labour market and exacerbate disparities in their access and use, leading to a new digital divide and growing inequality. Technologisation of production may also lead to an increase in unemployment, online fraud, and increased requirements for economic security for international business entities.

Table 6 provides a SWOT analysis of the impact of digitalisation on the international business environment through the prism of achieving the global sustainable development goals.

Table 6. SWOT analysis of the impact of digitalisation on the achievement of global sustainable development goals by the international business environment

Strengths	Weaknesses
Penetration of digital innovations into all areas of business and social life. Widespread use of online services. Growth of e-commerce and online sales. The use of digital economy technologies in the processes of greening the business environment. Access to various economic transactions 24/7. Expanding access to financial resources. Elimination of geographical restrictions in the international business environment. Growth in labour productivity and improvement of the quality of labour resources. Increased profitability of enterprises by reducing production and sales costs. Reduced time to bring new economic benefits to the market. The ability to establish quick feedback from customers. Improving the quality of international business results. Increased welfare of the population.	Declining profits and losses in a number of industries. High cost of digital transformation. Lack of or insufficient skills in using digital products among international business entities. Increased unemployment. Lack of a digital development strategy among international business entities. Increased requirements for economic security among international business entities. Dependence on technology. Countries with high levels of poverty. Insufficient level of trust in digitalisation processes.
Opportunities	Threats
Changes in consumer preferences towards a growing share of purchases through digital channels. Regulatory relief for ICT companies. Reducing energy consumption through the introduction of various smart technologies aimed at energy saving. Introduction of free access to the Internet. Reducing the cost of renting premises by transferring employees to remote work.	Increase in informal employment, reduction in the number of jobs, and rise in technological unemployment. Low level of digital infrastructure in developing countries and least developed countries. Insufficient broadband coverage in developing countries and least developed countries.

Table 6, Continued

Opportunities	Threats
<ul style="list-style-type: none"> Developing public-private partnerships to implement digital transformation projects. Reducing the digital divide between different countries. Providing a wider range of products. Emergence of new professions. Possibility of individualistic satisfaction of consumer needs. Improved living standards. Increased adaptability of international business to new market requirements. Reducing discrimination by promoting equal opportunities for people regardless of their gender, religion or age. 	<ul style="list-style-type: none"> Increased likelihood of cyber attacks and unauthorised access to personal and corporate data. Internet fraud. Technological and operational risks. Underestimation of new trends and innovation culture. Increased likelihood of funds being withdrawn from the country to hide assets from regulators. Violation of consumer rights related to the spread of e-commerce.

Source: prepared according to I. Kryvovyzyuk et al. (2021), N.E. Krasnostanova & T.A. Yakymenko (2023)

Despite the identified threats and weaknesses, the inevitable development of the digital economy can be argued. The forms and timing of digitalisation processes depend on the capabilities of the country, economy, industry, and people. Digitalisation implies a strategic business transformation, when customer preferences and behaviour change, corporate technology solutions are defined, and the entire business changes. The declared goals of digital transformation of companies in the context of ensuring the implementation of the Sustainable Development Goals range from the introduction of individual digital tools to the creation of multi-level ecosystems. It is worth noting that they will largely determine the content, stages, elements of digital transformation, required investments and projected e-ecosystems, and the portfolio of digital initiatives (Vakhovych *et al.*, 2021).

The analysed digitalisation experience of the Czech Republic, Hungary, Slovakia and Poland shows that the most advanced countries in terms of digitalisation are developing and funding government programmes for the research and implementation of blockchain technologies, which are spreading in many areas of human activity, including intellectual property protection, finance, e-voting, document management, critical infrastructure protection, etc. This technology has the potential to be used to store data on loans, property rights and other important information. In addition, the sources pay attention to the technologies of interaction between economic entities, introducing the concept of virtual or "hybrid worlds" (merging of the real and virtual worlds). In the virtual world, it is possible to perform a "meaningful" action in the real world through the virtual world. At the same time, the digital economy is also seen as an economic activity in which the main factor of production is digital data, or an activity related to the creation, distribution and use of digital technologies and related economic benefits.

In 2022-2023, the Group began to promote the paradigmatic principles of Industry 5.0, which is an expanded version of Industry 4.0 with social and environmental aspects. A distinctive feature of Industry 5.0 is the flexibility of production processes and optimisation

of environmental impact, as well as a focus on future harmonious development and human centricity through the prism of economic, technological, environmental and social development. That is why the new focus of digital technologies in the context of implementing a sustainable development strategy for the international business environment should be based on the principles of Industry 5.0. The concept of the fifth industrial revolution envisages the need to fully integrate social and environmental European priorities into innovative systemic technologies in six categories, the key of which, according to P.O. Skobelev & S.Yu. Borovik (2017), are human-machine interaction, bioinformation technologies, digital twins, artificial intelligence, energy efficiency and renewable energy technologies. The role of employees in Industry 5.0 is undergoing major changes. Employees are no longer seen as a cost to the company, but as an investment that ensures the company's growth and employee well-being. Under such conditions, human capital is more respected and valued. The key premise of Industry 5.0 is that technology serves people and people serve technology. An important concept of Industry 5.0 is the formation of an Internet ecosystem.

Conclusions

Thus, digital technologies can play a key role in implementing a sustainable development strategy, ensuring balanced economic, environmental and social progress. The study led to the conclusion that the digitalisation of the international business environment should be inclusive (complete and comprehensive) rather than targeted (improving the quality of individual systems and areas). This will have the greatest positive effect on the population and the economy. According to the experience of other countries, an increase in the share of the digital economy can lead to a 20% increase in GDP over a five-year period and a return on investment in digital transformation of up to 500%. However, this result will only be possible if digital initiatives cover all spheres of human life and are aligned with global sustainable development goals. Therefore, the removal of barriers to digital transformation should be achieved by combining the efforts of all levels of the global economy.

Alongside the development of digital infrastructure, it is important to prioritise digital transformation projects in international business. The implementation of digital projects requires organisational, managerial, and financial efforts on the part of the state, businesses, and citizens. Given the scale of such projects, their technical complexity, the need for significant capital investment, and the need for rapid deployment and coverage of large areas, it is advisable to introduce innovative and service models for financing the creation of new and reformatting existing business models. Prospects for further research will include assessing the impact of digital

technologies on the achievement of sustainable development goals for developed and developing countries, in particular, using economic and mathematical tools to confirm empirical postulates. In the future, it is necessary to determine the role of digital tools in Ukraine's economic growth and competitiveness in the post-war reconstruction period.

Acknowledgements

None.

Conflict of Interest

None.

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Оптимізація фокусу цифрових технологій в контексті реалізації стратегії сталого розвитку міжнародного бізнес-середовища

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Анотація. Активне поширення цифрових технологій формує темпи динаміки та тенденції розвитку міжнародного бізнес-середовища: з одного боку, підвищується гнучкість бізнес-сфери, з іншого боку, формуються нові виклики для стабільності бізнес-середовища, конкурентоспроможності традиційних галузей економіки, зокрема економічної та інформаційної безпеки. Метою статті було дослідження цифрово-інноваційної активності бізнес-середовища на основі порівняння і моделювання впливу незалежних змінних на валовий внутрішній продукт країн ЄС та України. Методологічною базою, що була використана під час дослідження став інструментарій економіко-математичного та кореляційного аналізу, порівняльний, кількісний, табличний аналіз та синтез, SWOT-аналіз. У статті проведено порівняльний аналіз значення показників міжнародних рейтингів, що відображають рівень цифрового розвитку країн Вишеградської групи та України за 2017-2023 роки; проведено оцінку цифрової та технологічної складових загального рейтингу міжнародної конкурентоспроможності України, Польщі, Чехії, Угорщини та Словаччини. Шляхом використання економетричного аналізу було обґрунтовано використання лінійної функції залежності, яка детально описує динаміку економічного розвитку; побудовано багатофакторну економіко-математичну модель, що визначатиме силу зв'язку між показниками цифрово-інноваційної активності бізнесу в Україні та основним макроекономічним показником – ВВП; проведено SWOT-аналіз впливу цифровізації на досягнення міжнародним бізнес-середовищем глобальних цілей сталого розвитку; обґрунтовано напрями нового фокусу цифрових технологій в контексті реалізації стратегії сталого розвитку міжнародного бізнес-середовища. Практичне значення результатів полягає в тому, що основні наукові положення доведено до рівня методичних розробок, які можуть бути використані: суб'єктами господарювання – під час вибору для використання цифрових технологій, підвищення власної конкурентоспроможності на міжнародній арені; суб'єктами генерування інновацій – під час розробки цифрових інновацій, розвитку інноваційних хабів; органами влади – під час розробки нормативної бази щодо впровадження цифрових інновацій задля досягнення глобальних цілей сталого розвитку, розвитку цифрової інфраструктури, регулювання інвестиційних операцій

Ключові слова: глобальні цілі сталого розвитку; бізнес-суб'єкти; цифрово-інноваційна активність; діджиталізація; Індустрія 4.0; Індустрія 5.0