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# Digital Imperative for the Development of the Global Economy

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ANNOTATION. The article substantiates the hypothesis that there is no alternative to digital transformation of business, public administration, and society as a whole in the current composition of scientific and technological trends in global development. The article systematically identifies digital technologies based on big data, grid computing, blockchain and actually implemented in global business, such as the industrial Internet, robotics, digital marketing, fintech, govtech, e-medicine and education, etc. It is emphasised that they are the key drivers of the digital economy as a new phenomenon and a new reality. The author summarises the conceptual and categorical apparatus and shows the archetypes of the digital economy. Its status is illustrated in the format of indicators of influential global indices. The article states the obvious positive aspects of digitalisation of the economy – accessibility, transparency and efficiency of resource use, high productivity and cheaper services, fast access to markets, communication mobility, energy efficiency and environmental friendliness – and shows its possible negative aspects, such as cybercrime, electricity shocks, unemployment, insecurity of personal information, discrediting traditional cultural and behavioural values. A SWOT analysis of the digitalisation of the Ukrainian economy according to the Global Digital Competitiveness and Network Readiness indices is carried out and the ways and priority tasks of its intensification in the European integration direction of development are outlined – 4G mobile coverage, availability of clean energy, neutralisation of high investment risks, proper legal regulation of intellectual property and ICT activities. The key role of e-governance strategies and practices in the process of digital transformation of national economies is substantiated on the basis of a comparative cross-country analysis. The author's own logic of digital economy transformation is presented, based on promising scientific and technological trends generated by nano-, bio-, neuro-, quantum- and artificial intelligence. The author substantiates the objective conditionality of the formation of a smart economy, primarily in the format of smart enterprises, cities and communities.

KEYWORDS: globalisation, technological progress, digital technologies, digital economy, virtual economy, artificial intelligence, smart economy.

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## Introduction

Technoglobalism, which has dominated in recent decades, accelerated by the neoliberal model of capitalism in the era of globalisation, has led to the emergence and dominance of the knowledge economy and the information economy. In conceptual terms, they, in turn, gave rise to the phenomenon of the digital economy, which became a new reality in the 2000s.

The development of digital technologies, their constant generation and scaling with penetration into the sphere of human life have become primarily a global driver of the digital economy. In methodological terms, it has become a new stage in the evolution of the post-industrial knowledge economy, and in technological terms, it is the result of the evolution of the empirical model-based empirical economy and the analogue model-based analogue economy.

In recent years, the problems of the digital economy and certain aspects of its functioning and transformation have been the focus of attention of many researchers, as evidenced by numerous foreign and domestic publications, in particular, by Vaclav Smil[4], Goodman Mark[5], Chris Skinner[6], Alexander Kudya[7], Olga Mozgalli[8].

Among the most fundamental works of Ukrainian scholars, we note the study "Digital Economy: the Impact of ICT on Human Capital and the Formation of Competencies of the Future" (L. Antoniuk, D. Ilnytskyi, A. Sevastiuk, etc.[9]), which provides a comprehensive analysis of the qualitative and quantitative parameters of the current state of the digital economy.

At the same time, the issues of systematic identification of digital technologies, conceptual and categorical definition of the essence of the digital economy and reliable quantitative assessment of its scale, and predictive assessments of further digital transformation at the micro, macro and global levels remain insufficiently covered in monographic works and scientific periodicals.

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[4] Vaclav Smil, *How the World Really Works: Past, Present and Future from the Point of View of Science*, trans. Alexander Stukalo, 2nd ed. (K.: Laboratory, 2023), 312 p. [In Ukrainian].

[5] Mark Goodman, *Crimes of the Future*, trans. I. Mazarchuk and Y. Mashiko (Kharkiv: Ranok Publishing House: Fabula, 2019), 592 p. [In Ukrainian]

[6] Chris Skinner, *Digital Man*, trans. G. Yakubovska (Kharkiv: Ranok Publishing House: Fabula, 2020), 272 p. [In Ukrainian].

[7] A. Kud, M. Kucheriavenko, and Y. Smychok, *Digital Assets and Their Economic and Legal Regulation in the Light of the Development of Blockchain Technology* [monograph] (Kharkiv: Pravo, 2019), 384 p. [In Ukrainian].

[8] D. G. Lukianenko, O. P. Mozgalli, O. D. Lukianenko, I. V. Dvornik, and M. O. Orekhov, "Digital Imperative of Transformation of Universities' Activities," *Financial and Credit Activities: Problems of Theory and Practice* (2020), no. 4 (35): 449-456, https://doi.org/10.18371/fcaptp.v4i35.222478. [In Ukrainian]

[9] *Digital Economy: The Impact of ICT on Human Capital and the Formation of Competences of the Future*, ed. L. L. Antoniuk, D. O. Ilnytskyi, and A. O. Sevastiuk (Kyiv: KNEU, 2021), 337 p. [In Ukrainian].

The purpose of the article is to substantiate the hypothesis that there is no alternative to the digital imperative for the development of the global economic system based on a systematic assessment of key trends and prospects for scientific, technological, socio-economic progress.

## Digital technologies in the global economy

The unprecedented quality and dynamics of scientific and technological progress over the past two decades has resulted in the establishment of a new technological order – Industry 4.0 – based on composite, powder, ceramic, fibre-optic, and other new materials, new, mostly carbon-free energy, and mathematical computing in the form of big data.

Today, digital technologies are driving the development of industry 4.0, which raises the issue of their systemic identification in modern production, trade, finance, and management.

The study by L. Antoniuk. D. Ilnytskyi, A. Sevastiuk and other scientists present an interpretation of the interconnection of the sufficiently well-defined technologies 4.0 technologies (industrial Internet of Things platforms, big data and analytics, cloud computing, adaptive manufacturing, augmented and virtual reality, simulations (industrial stimulation models), digital twin, horizontal and vertical systems, artificial intelligence and machine learning), robotics (autonomous mobile robots), cyber-physical systems, 5G, Starlink satellite internet, cybersecurity) with the primary, secondary, tertiary, quaternary and quintessential sectors of the economy and transformational changes in their structure due to digitalisation[10].

Based on a selective synthesis of foreign and domestic scientific periodicals, expert opinions and corporate practices, we propose a macro-composition of digital technologies (Fig. 1). In our opinion, it is crucial to distinguish three fundamental basic components: big data, grid computing, and blockchain. Big data is a technology for collecting, processing and storing structured and unstructured data sets characterised by a significant volume and rapid rate of change (including in real time), which requires special tools and methods for working with them.

Grid computing is a geographically distributed infrastructure that combines many different types of resources that can be accessed by a user from any location, regardless of their location. Grid provides a collective distributed mode of access to resources and related services within globally distributed organisations (enterprises that share global resources, databases, specialised software).

[10] Ibid.

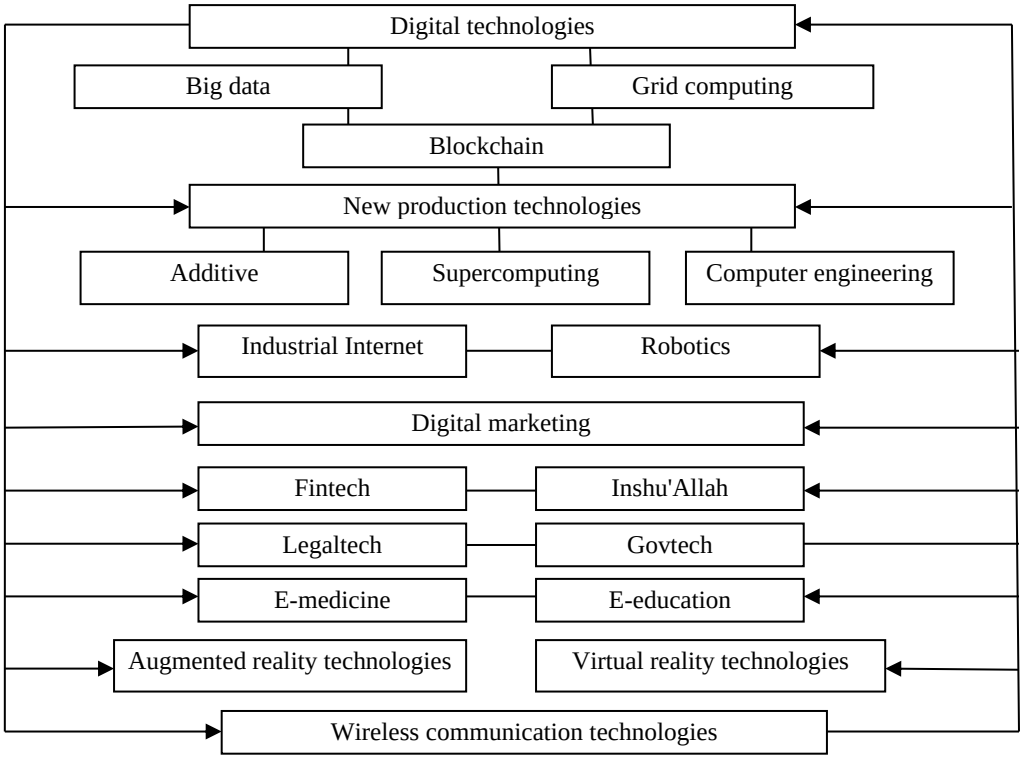


Figure 1. Macro composition of key digital technologies

Blockchain as a unique type of database, where all the above information is stored in blocks in chronological order, deserves in-depth analysis and is the subject of special research[11,12,13,14,15,16,17].

[11] C. Laroiya, D. Saxena, and C. Komalavall, "Applications of Blockchain Technology," in *Handbook of Research on Blockchain Technology*, ed. Elsevier (2020), pp. 213-243, https://doi.org/10.1016/b978-0-12-819816-2.00009-5.

[12] P. Domjan, G. Serkin, B. Thomas, and J. Toshack, "Introducing Blockchain: Tomorrow's Railroads," in *Chain Reaction* (2021), pp. 1–8, https://doi.org/10.1007/978-3-030-51784-7_1.

[13] L. Schlecht, S. Schneider, and A. Buchwald, "The Prospective Value Creation Potential of Blockchain in Business Models: A Delphi Study," *Technological Forecasting and Social Change* 166 (2021): Article 120601, https://doi.org/10.1016/j.techfore.2021.120601.

[14] L. Stockburger, G. Kokosioulis, A. Mukkamala, and R. R. Mukkamala, "A Vital Blockchain-Enabled Decentralized Identity Management: The Case of Self-Sovereign Identity in Public Transportation," *Blockchain: Research and Applications* 100014 (2021), https://doi.org/10.1016/j.bcra.2021.100014.

[15] M. A. Uddin, A. Stranieri, I. Gondal, and V. Balasubramanian, "A Survey on the Adoption of Blockchain in IoT: Challenges and Solutions," Blockchain: Research and Applications 100006 (2021), https://doi.org/10.1016/j.bcra.2021.100006.

[16] UNCTAD, "Harnessing Blockchain for Sustainable Development: Prospects and Challenges," paper presented at the United Nations Commission on Science and Technology for Development Inter-sessional Panel 2020-202118-22 January 2021, Geneva, Switzerland, 2021.

[17] Kud A. Digital assets and their economic and legal regulation in the light of the development of blockchain technology: a monograph / Alexander Kud, Mykola Kucheriavenko, Yevhen Smychok. Kharkiv: Pravo, 2019. 84 p. [In Ukrainian]

Given its all-encompassing nature, it is important to position digital technologies by sector and industry.

Today, digital manufacturing technologies include:

a) Additive technologies – technologies for the layer-by-layer creation of three-dimensional objects based on their digital models ("twins"), which allow the manufacture of products of complex geometric shapes and profiles;

b) supercomputer technologies – technologies that provide high-performance computing through the use of parallel and distributed (grid) data processing and high throughput;

c) computer engineering – technologies for digital modelling and design of facilities and production processes throughout the entire life cycle.

The Industrial Internet functions as a data network that connects devices in the manufacturing sector that are equipped with sensors and can interact with each other and/or the external environment without human intervention.

Robotics are production systems with three or more degrees of mobility (freedom), built on the basis of sensors and artificial intelligence, capable of perceiving the external environment, controlling their actions and adapting to its changes.

Digital marketing is a set of promotion tools using digital promotion channels, including contextual and teaser advertising, display and banner advertising; promotion on social media and blogs; creation of mobile applications for smartphones, tablets and other media; and viral advertising. In this context, internet marketing should be considered one of the components of digital marketing.

Modern fintech provides, firstly, financial services software and services (B2B model), and secondly, it covers the B2C market and competes with traditional financial service providers in the struggle for a mass customer. The penetration of fintech services in the leading countries is estimated at 40–70 % of transactions in financial markets[18].

Inshuetech is focused on implementing innovative solutions designed to maximise the efficiency of using new technologies in the insurance market by making traditional insurance products digital.

Through digitalisation, Legaltech specialises in information technology support for professional legal activities, and, secondly, in providing legal services to consumers.

Digitalisation in the public administration sector is of particular importance. Today, Govtech includes all IT products, solutions, developments, and services that help solve public sector problems (creation of platforms for citizen collaboration, electronic petitions, crowdsourcing,

[18] Borysiuk O., Datsiuk-Tomchuk M., Lipovska-Makovetska N. Imperatives of the development of the financial market of Ukraine in the context of digitalisation. *Economic Journal of Lesya Ukrainka Eastern European National University*. 2020. No. 2. P. 168–176. DOI: http://doi.org/10.29038/2411-4014-2020-02-168-176. [In Ukrainian]

electronic identification, provision of services in education, healthcare, regulation, and administration). Estonia is a breakthrough European example of digital governance, and in Ukraine, the greatest results of digitalisation are demonstrated in the sphere of state regulation, largely due to the creation of the Ministry of Digital Transformation. In particular, the Diia product is ahead of its foreign counterparts in terms of technology and accessibility.

In recent years, especially during the Covid-19 epidemic, e-medicine has become much more active, primarily due to the electronic prescription algorithm in the doctor-pharmacy-patient relationship. E-education is also developing rapidly, driven by the Covid-19 epidemic and martial law in Ukraine. Among the progressive digital innovations, it is worth noting, first of all, distance education using Google, Moodle and other platforms, online courses (Massive on-line open course), etc. At the same time, educational programmes and disciplines (digital economy, digital finance, digital accounting, digital marketing, etc.) are undergoing a qualitative transformation. The latest trend in education is the creation of digital schools and digital universities[19,20].

Wireless communication technologies, especially fifth-generation (5G) technologies with high bandwidth (at least 10 Gbps), network reliability and security, and low data transmission latency (no more than one millisecond) are revolutionary for rapid digitalisation.

In today's realities, and especially in the future, the interconnection of digitalisation and virtualisation processes is becoming increasingly close. In this regard, the following are distinguished: virtual reality technologies (computer modelling of a three-dimensional image or space, through which a person interacts with a synthetic («virtual») environment with subsequent sensory feedback); augmented reality technologies (visualisation based on adding information or visual effects to the physical world by overlaying graphic and/or sound content to enhance the experience and interactive capabilities).

It is clear that in the field of system analysis and management of digitalisation, there are other systematisations of modern digital technologies, for example, with their division into: basic (5G communication, Internet of Things, robotics); auxiliary (additive manufacturing (3G printing), cloud computing, big data and its analysis, artificial intelligence and machine learning, augmented and virtual reality, cybersecurity, quantum computing, software intelligent agents, blockchain);

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[19] Lukianenko D. G., Mozgalli O. P., Lukianenko O. D., Dvornik I. V., Orekhov M. O. Digital imperative of transformation of universities' activities. *Financial and Credit Activities: Problems of Theory and Practice*. 2020. No. 4 (35). P. 449–456. DOI: https://doi.org/10.18371/fcaptp.v4i35.222478 [In Ukrainian]

[20] Butko M. P., Murashko M. I., Nazarko S. O. Modern aspects of digitalisation and implementation of artificial intelligence in the activities of higher education institutions of Ukraine. *Economy of Ukraine*, 2022. No. 11(732). P. 76–86. DOI: https://doi.org/10.15407/economyukr.2022.11.076 [In Ukrainian]

application domains (remote control of devices (in production, unmanned vehicles, medicine, etc.), technological solutions using 5G communications, unmanned vehicles, smart cities, digital health (condition monitoring sensors, autonomous injection devices), digital payments, payments)[21].

In general, the systematisation of digital technologies is the most open and potentially productive research arena.

## The emergence and dimensions of the digital economy

In the process of active interdisciplinary research, scholars have formulated and disseminated dozens of definitions of the digital economy in the academic environment with a fairly representative domestic source base[22]. Among the modern conceptual modifications, when the digital economy is interpreted as a certain "environment", "type of relationship", "process", "activity", "model", "industry", etc., the common thing is the identification of ICT as the basis of economic activity.

In our opinion, the most universal and productive definition in this discourse is that of Ukrainian researchers, who interpret the digital economy as an activity closely related to the use and implementation of information and communication technologies, in the process of which added value and public goods are created[23]. Based on the methodology of the experts of the international consulting company Arthur D. Little[24], the authors give its narrow interpretation (the ICT sector with its digital functions, solutions, services and products) and a broad interpretation (sharing economy, E-business, Industry 4.0, precision agriculture, freelance economy, algorithm economy, E-commerce, E-healthcare, E-education)[25].

Based on the fact that digitalisation processes are institutionalised in a certain way and have their own country-specific organisational and economic characteristics, Arthur D. Little identifies several archetypes of the digital economy:

- innovation hubs (the USA, South Korea, Norway, the UK, China, Israel), where the world's largest technology companies are based and conditions for the development of start-ups are created;

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[21] *Digital economy. The impact of ICT on human capital and the formation of competences of the future*. Monograph / Edited by Doctor of Economics, Professor L. L. Antoniuk, Doctor of Economics, Professor D. O. Ilnytskyi, A. O. Sevastiuk. Kyiv: KNEU, 2021. 337 p. [In Ukrainian]

[22] Dubyna M. V., Popelo O. V., Tarasenko O. O. Institutional transformations of the financial system of Ukraine in the context of the development of the digital economy. *Problems and prospects of economics and management*. 2021. No. 1(25). P. 91–105. DOI: 10.25140/2411-5215-2021-1(25)-91-110. [In Ukrainian]

[23] *Digital economy. The impact of ICT on human capital and the formation of competences of the future*. Monograph / Edited by Doctor of Economics, Professor L. L. Antoniuk, Doctor of Economics, Professor D. O. Ilnytskyi, A. O. Sevastiuk. Kyiv: KNEU, 2021. 337 p. [In Ukrainian]

[24] Ibid.

[25] Ibid.

- efficient producer/consumer (Germany, France, Japan), where they actively implement innovations and participate in ICT value chains. Countries of this archetype aim to increase the competitiveness of all sectors of the economy through technological innovation and research and development;
- strong service centre (Ireland, Brazil, Philippines, Ukraine), where a strong service centre is being established, forming a global ICT service offering;
- global factory (Thailand, Malaysia, Mexico), where the key competitive factor is cheap labour in ICT production;
- business hubs (Singapore, Turkey, South Africa), where the key characteristic of the countries is the presence of a favourable business environment, which allows them to be a regional business centre and participate in global ICT value chains as trading platforms;
- advanced ICT consumers (Canada, Saudi Arabia, Russia), where the difference from Efficient Producers/Consumers is the low participation in ICT value chains and high consumption of information and communication services;
- novice in ICT (Egypt, Nigeria, Zambia, Pakistan), which have the lowest contribution to ICT value chains, and are also characterised by economic and geopolitical instability, low levels of education[26].

We believe that the study of the essence of the digital economy should be based on its understanding not only as the latest phenomenon of informatisation and virtualisation, but also as a product of the evolution of economic systems in the post-industrial development paradigm, which forms the most dynamic and profitable segment of the global market[27]. In this conceptual format, the issues of its primarily economic dimensions become relevant. The rapid spread of digital technologies, the fragmentation of official macro statistics, and the cross-sectoral nature of digitalisation make it difficult to assess its scale. At the same time, numerous expert and analytical assessments characterising various components and specifics of the digital economy are constantly updated and made available to the public via the Internet. Targeted global rankings and indices, materials of global consulting companies (Arthur D. Little, A. T. Keazney, DWC, Deloitte, McKinsey) and a number of international organisations form the relevant source of information.

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[26] *Digital economy. The impact of ICT on human capital and the formation of competences of the future*. Monograph / Edited by Doctor of Economics, Professor L. L. Antoniuk, Doctor of Economics, Professor D. O. Ilnytskyi, A. O. Sevastiuk. Kyiv: KNEU, 2021. 337 p.

[27] Lukianenko D. G., Mozgalli O. P., Lukianenko O. D., Dvornik I. V., Orekhov M. O. Digital imperative of transformation of universities' activities. *Financial and Credit Activities: Problems of Theory and Practice*. 2020. No. 4 (35). P. 449–456. DOI: https://doi.org/10.18371/fcaptp.v4i35.222478 [In Ukrainian]

The current international rankings in the field of digitalisation can be divided into two groups:

– specialised UN and EU institutions (Global Innovation Index (GII), calculated since 2007. International Business School INSEAD (France) and Cornell University (USA) with the support of the World Intellectual Property Organisation (WIPO); E-Participation Index (EPART), published by the UN and characterising the degree of development of active communication services between citizens and the state; Electronic Government Development Index (EGDI), calculated by the UN Department of Economic and Social Development (UNDESA) every two years and measuring the readiness and ability of national governments to use ICTs for organising The Digital Economy and Society Index (DESI), calculated annually by the European Commission, assesses the state of digitalisation of EU countries and measures the readiness and ability of national governments to use ICT for organising and managing their business;

– international private entities (Global Competitiveness Index (GCI), published by Huawei since 2014 to assess the progress of the world's largest countries in the development of digital technologies; BCG e-Intensity Index, compiled by Boston Consulting Group (BCG) since 2008, which measures the level of digital economy development in 85 countries. and assesses the level of development of the digital economy in 85 countries; Digital Evolution Index (DEI), compiled by Tufts University (USA) in cooperation with Mastercard, taking into account two main factors: a) the current level of digital development; b) the growth rate of digitisation; World Digital Competitiveness Index (WDCI), compiled by the Swiss Business Scale IMD and reflects the assessment of the capabilities and readiness of countries to adapt to the development of digital technologies; Information and Communication Technology Development Index (IDI), calculated by the United Nations International Telecommunication Unit (UNITU) since 2009. as part of the annual report "Measuring the Information Society" and allows to track the dynamics of a country's development in the field of ICT. Selective positioning of countries with the level of digitalisation is shown in Table 1.

Almost all of the above and other (regional and country) indices are used by both foreign and Ukrainian researchers of the digital economy. Thus, for an in-depth comparative analysis of the digitalisation of economies around the world, we have selected two of the above indices. The Global Digital Competitiveness Index assesses the speed of technological transformation taking place in countries, thereby helping to shape government policy decisions in the field of national economic competitiveness and strategic business decisions. It aims to assess the level of a country's acceptance of digital technologies that lead to transformation in government practices, business models, and society as a whole. In the 2020s, the study covered

more than 60 countries, each of which was assessed based on an analysis of 50 indicators in three main areas: "Knowledge (intangible infrastructure, the process of digital transformation through the discovery, understanding and study of new technologies); Technology (the general context for ensuring the introduction and development of digital technologies, technological regulation, availability of capital for investment in technological infrastructure, etc.

*Table 1*

POSITIONS OF LEADING COUNTRIES IN THE DIGITALISATION OF THE ECONOMY AND BUSINESS ACCORDING TO GLOBAL DIGITAL INDICES

| **EGDI, 2021** | **EPI, 2022** | **NRI, 2023** | **DESI, 2022** | **GCI, 2022** | **IDI, 2023** |
|---|---|---|---|---|---|
| 1. Denmark<br>2. Finland<br>3. Republic of Korea<br>4. New Zealand<br>5. Sweden<br>...<br>45. Czech Republic<br>**46. Ukraine**<br>47. Slovakia<br>... | 1. Japan<br>2. Australia<br>3. Singapore<br>4. Estonia<br>5. The Netherlands<br>...<br>**57. Ukraine,** Mongolia, Czech Republic<br>... | 1. USA<br>2. Singapore<br>3. Finland<br>4. The Netherlands<br>5. Sweden<br>...<br>42. Thailand<br>**43. Ukraine**<br>44. Brazil<br>... | 1. Finland<br>2. Denmark<br>3. The Netherlands<br>4. Sweden<br>5. Ireland | 1. Singapore<br>2. Switzerland<br>3. Denmark<br>4. Australia<br>5. 5. Finland, Norway<br>...<br>**74. Ukraine**<br>... | 1. Kuwait<br>2. Singapore<br>3.Denmark, Estonia<br>4. Finland<br>5. USA |

*Source*: developed by the authors.

The Network Readiness Index (NRI) measures the level of ICT and digital economy development in countries around the world based on 62 key parameters, which are grouped into four main groups:

A. Technology – assesses access (the fundamental level of ICT in countries, including connectivity and accessibility infrastructure), content (the type of digital technology produced in countries, as well as content/applications that can be deployed locally) and future technology readiness (the level of readiness of countries for the future in the digital economy and new technological trends such as artificial intelligence and the Internet of Things;

B. People – assesses the readiness of citizens, security and government agencies to use ICTs (access, resources and skills for their productive use in the economy).

C. Governance – assesses the level of governance of the digital transformation of the economy (level of trust, cyber security, security and

privacy skills), regulation (government regulation to support the development of the digital economy) and connectivity (digital divide within the country and governance to address inequalities such as gender, disability and socio-economic status).

D. Impact – assesses the contribution of ICTs and the digital economy to digital growth and well-being, the economic impact of participating in the development of the digital economy, quality of life (the impact of the digital economy on the social sphere) and the country's contribution to the Sustainable Development Goals (goals in which ICTs play an important role, including indicators such as health, education and the environment).

Summarising the criteria and parameters of global digital competitiveness and network readiness, we conducted a SWOT analysis of Ukraine's digital economy (Table 2).

*Table 2*

SWOT ANALYSIS OF THE DIGITAL ECONOMY

| Strengths | Weaknesses |
|---|---|
| *Global digital competitiveness* | |
| Opportunities to start a business<br><br>Internet connection speed | Protection of intellectual property rights<br>Financial and banking services<br>High investment risks |
| E-democracy<br>Using big data<br>Quality of training | Level of cyber security |
| *Network readiness* | |
| Literacy rate of the population<br>Legislation in the field of e-commerce<br>Number of internet subscribers<br><br>International internet bandwidth<br>Affordability of mobile services<br>Opportunity to start a business<br>E-democracy<br><br>Using big data<br>The level of quality of education | Legal regulation of ICT activities<br>4G mobile coverage<br>Number of mobile broadband subscribers<br>Access to clean energy<br><br>The cost of mobile phones<br><br>Level of well-being<br>Opportunity for digitalisation of rural areas |

*Source*: developed by the authors.

It has been found that the strengths recognised in both influential rankings include the use of big data, e-democracy, quality of education, and opportunities to start a business. Opportunities to increase digital efficiency

should be sought in overcoming the overall digital divide (4G mobile coverage, access to clean energy and high investment risks, increased prosperity, and proper legal regulation of intellectual property and ICT activities. Since both the benefits and possible threats of comprehensive and accelerated digitalisation are unevenly distributed among countries and regions of the world, it is important not only to consider their levels of economic development, which determine the resource and institutional capabilities of digital interaction, but also the available digital skills and digital literacy of societies in general. In Ukraine, this is characterised by the following data: per 100 households, the availability of electronic and digital means of life in 2016–2020 increased significantly (personal computers – 47/38, mobile phones – 255/201, laptops – 45/27, tablets – 29/15; access to Internet services in 2021 82.7 % of households had access to the Internet, including 79.3 % of active users (in EU countries, from 72 % (Bulgaria) and 74 % (Spain) to 99 % (Luxembourg, Norway, the United Kingdom)[28].

In the context of identifying the key drivers of the development of Ukraine's digital economy, it is indicative to assess the role of various institutions in the development of the digital economy (Table 3).

The role of governments in the development of national digital economies is crucial. At the national level, relevant strategies and programmes have been developed since the late 1990s and early 2000s (Denmark in 2000, Singapore in 2005, Australia; Hong Kong, the United Kingdom, and New Zealand in 2008. New Zealand – in 2008, EU countries – in 2009, Canada – in 2010, Malaysia – in 2012, South Korea – in 2013, India and Kazakhstan – in 2015, Ukraine – in 2019). As a rule, most governments have similar goals and objectives of digital transformation based on the development of the ICT sector and consumers of digital solutions through support of relevant research and development, their implementation, stimulation of demand for digital technologies, and creation of appropriate public infrastructure.

In more pragmatic terms, a comprehensive approach to strategic public administration of digitalisation should include: digital transformation of public administration; development of information and communication infrastructure; strengthening of information security; development of digital skills and competences. It is clear that in the global digital landscape, national strategies for building digital economies are usually agreed upon as part of broader international projects and initiatives.

[28] *Butko M. P., Murashko M. I., Nazarko S. O.* Modern aspects of digitalisation and implementation of artificial intelligence in the activities of higher education institutions of Ukraine. *Economy of Ukraine,* 2022. No. 11(732). P. 76–86. DOI: https://doi.org/10.15407/economyukr.2022.11.076 [In Ukrainian]

*Table 3*

**ASSESSMENT OF THE ROLE OF INDIVIDUAL INSTITUTIONS IN THE DEVELOPMENT OF THE DIGITAL ECONOMY DEPENDING ON THEIR STATUS AND EMPLOYMENT**[29]

| | Average score of the impact assessment* | | | | | Rank of impact assessment** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Academic community | Civil service | Business sector | Temporarily down | Public sector | Academic community | Civil service | Business sector | Temporarily down | Public sector |
| Public authorities | 1,950 | 1,976 | 1,893 | 1,731 | 2,000 | 4 | 4 | 4 | 4 | 4 |
| Local authorities | 1,669 | 1,857 | 1,607 | 1,536 | 2,028 | 6 | 5 | 6 | 6 | 6 |
| Business (companies and entrepreneurs) | 2,439 | 2,119 | 2,533 | 2,001 | 1,990 | 2 | 3 | 1 | 3 | 3 |
| Higher and vocational education institutions | 1,973 | 2,309 | 1,914 | 2,037 | 1,982 | 3 | 2 | 3 | 2 | 2 |
| Developers of digital products and services | 2,596 | 2,452 | 2,523 | 2,073 | 2,162 | 1 | 1 | 2 | 1 | 1 |
| Public organisations and professional associations | 1,410 | 1,762 | 1,687 | 1,576 | 1,945 | 5 | 6 | 5 | 5 | 5 |

* 1 point – minimum; 2 points – average; 3 points – maximum.

** 1 point is the highest; 6 points is the lowest.

*Source*: developed by the authors.

In general, the undeniable effects of digitalisation are virtually undisputed today (economic – accessibility, transparency and efficiency of resource use; productivity and cheaper services, faster access to markets, decentralised mobility, energy efficiency and environmental friendliness; social – accessibility and cheaper education and healthcare, transparency of state and municipal procedures and services, communication interaction between civil society institutions, etc.)

Among the already empirically confirmed positive aspects of the digital economy, it is important to emphasise the importance of digital global

[29] *Digital economy*. The impact of ICT on human capital and the formation of competences of the future. Monograph / Edited by Doctor of Economics, Professor L. L. Antoniuk, Doctor of Economics, Professor D. O. Ilnytskyi, A. O. Sevastiuk. Kyiv: KNEU, 2021. 337 p. [In Ukrainian]

exports, which provide unprecedented opportunities for significant growth in the production of goods and services, as the digital economy is growing much faster than the traditional one with higher (2-3 times) labour productivity. It provides 5–20 % of GDP growth, depending on the country.

Another obvious positive of digitalisation is its productive impact on addressing the problem of growing cross-country inequality, as the share of digital economies in developing countries is increasing by 15–25 % annually, according to WEF estimates, and the growth of average wages in the digital industry in the South could lead to global income convergence. New markets for digital start-ups in developing countries will be tapped, and digital platforms will avoid inefficient labour institutions and relations.

As a complex and naturally contradictory process, the digitalisation of the global economy is accompanied by new challenges and threats. In our opinion, it is advisable to divide them into three groups:

1) technological (the possibility of cyberattacks at all levels; systemic risk of electricity shock or collapse;

2) socio-economic (possibility of mass unemployment, problems of productive use of free time; demographic, economic and social deformations of international migration processes;

3) moral and spiritual (total identification and surveillance with unprotected personal information; discrediting traditional cultural and behavioural values).

Based on the understanding of the technological priority of digitalisation and the already accumulated global experience, the first group of threats is the most real and destructive, and it is undoubtedly global in nature. This, in particular, was vividly described by Mark Goodman, who conducted a revealing study of not only the origins, but also the manifestations and global schemes of cybercrime[30].

In general, given the obvious positives, primarily in the development of global business and governance, and the possible negatives, which are currently considered hypothetical, we can expect the traditional economy to be replaced by the digital economy rather quickly in almost all countries and regions of the world.

## Prospects for digital transformation

The decisive economic feature of the latest digital technologies, which ensures their unprecedented scaling in terms of dynamics and geography, is their impressive exponentiality, when the accelerator of the digital economy

[30] Goodman Mark. Crimes of the Future / Translated from English by I. Mazarchuk, Y. Mashiko. Kharkiv: Ranok Publishing House: Fabula, 2019. 592 p. [In Ukrainian]

is not so much productivity or new quality, but the reduction in the cost of technological solutions. For example, the cost of sensors, which is one of the most important components of IoT systems, has shown a steady decline from $0.95 in 2008 to $0.44 in 2018. The cost of industrial robots has also halved. For a number of digital technologies, such as artificial intelligence, Big Data, etc., a significant driver of development is the reduction in the cost of information storage: from an average of USD 0.12 per 1GB in 2009 to USD 0.028.[31]

In parallel, high-tech global business generates the effects of network and platform economies as a natural environment for the development of the digital economy. Business processes and models are undergoing a qualitative transformation with a focus on the formation of global digital ecosystems. At the same time, e-governance simplifies and makes public services transparent, contributing to international anti-corruption harmonisation, cybersecurity, etc.

However, it is becoming increasingly clear that the long-term prospect of digitalisation is linked to interconnected trends of a higher technological order, where the key drivers of progress are biotechnology (based on the use of living organisms and biological processes in production, agriculture and medicine with the application of high technologies); nanotechnology (development, packaging, testing of microelectronic products based on the achievements of colloidal chemistry, colloidal physics, molecular biology, microelectronics); quantum technologies (creation of computer systems based on new principles (quantum effects) that allow for a radical change in the way large amounts of data are transmitted and processed); artificial intelligence – a system of software and/or hardware capable of perceiving information, learning and making decisions based on the analysis of large amounts of data, including imitating human behaviour, with a certain degree of autonomy; neurotechnologies (cyber-physical systems that partially or fully replace/supplement the functioning of the nervous system of a biological object, including on the basis of artificial intelligence).

In this largely futuristic discourse, using our own methodology of predictive assessments[32], we propose the following logic of digital economy transformation (Fig. 2).

[31] Ivanchenko N. O., Kudrytska Z. V., Rekachynska K. V. Business models in the context of digital transformations. *Series: Economics and management*. Vol. 31 (70). No. 3 (20). P. 185–190. doi: https://doi.org/10.32838|2523-4803|70-3-65. [In Ukrainian]

[32] Lukianenko D. G., Mozgalli O. P., Lukianenko O. D., Dvornik I. V., Orekhov M. O. Digital imperative of transformation of universities' activities: *Problems of Theory and Practice*. – 2020. – No. 4 (35). – P. 449–456. [In Ukrainian]

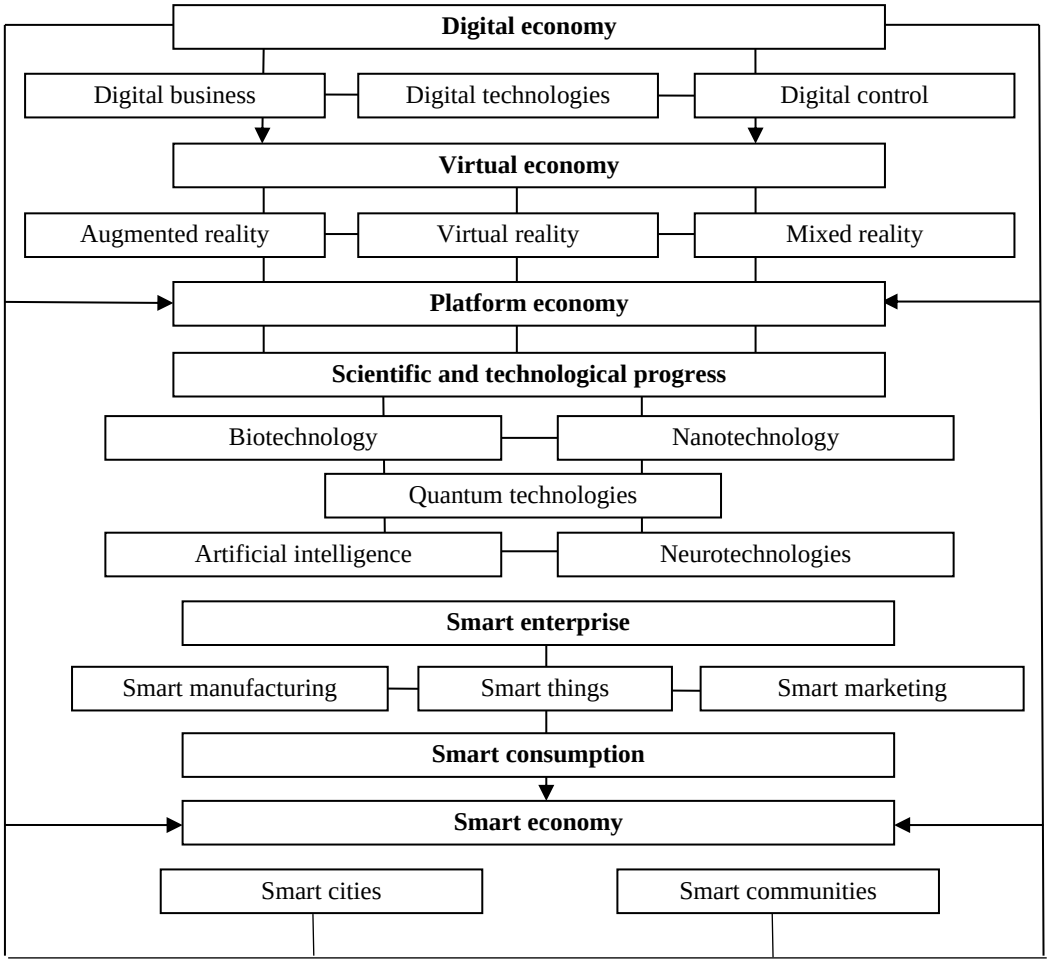


Figure 2. The logic of digital economy transformation

*Source*: developed by the authors.

In the process of transition to a smart economy, we can observe a focus of research attention mainly on the phenomenon of smart cities, which, in our opinion, is due to its certain scientific validity, the practice of creation and even functioning, and the availability of relevant international rating methodologies, in particular the Smart City Index (Collection methodology for Key Performance Indicators for Smart Sustainable Cities). In general, we can state that there are quite defined and specific indicators of smart cities in various areas of their functioning: smart electricity meters; air pollution control; solid waste collection; household Internet access; wireless broadband coverage; free WI-FI access in

public places; public transport monitoring; availability of a common transport mode; ICT monitoring of ICT electricity supply; integrated building management systems; pedestrian infrastructure; urban development and spatial planning; number of video cameras; emergency response time; student access to ICT; electronic medical records; health insurance; employment in the ICT sector; support for start-ups; availability of childcare; infrastructure and services for people with special needs; open data; e-government; e-procurement in the public sector; Big Data collection and analysis; personal data security, etc.

Instead, the methodology and practice of implementing smart economy models are at the initial stage of development, requiring international consolidation of efforts by researchers, experts and practitioners.

Drawing attention to the historical and regular underestimation of new technologies, Anders Indset warns that humanity is fatally underestimating the revolutionary impact of artificial intelligence[33], proposes a global model of the quantum economy, based on humanistic capitalism – post-materialist, sustainable and circular[34].

The fact that in the neoliberal paradigm of global capitalism, digitalisation and artificial intelligence technologies will not have a positive civilisational effect, reproducing and exacerbating socio-economic inequality and provoking new imbalances and asymmetries, is emphasised by most unbiased scholars and experts[35,36,37]. That is, further digital transformation in line with technological progress should be accompanied by a search for a new global paradigm and model of global economic development.

## Conclusions

The prerequisites and key scientific, technological, economic, institutional, legal and socio-cultural factors for the emergence of the digital economy were formed in the process of the revolutionary impact of digital technologies on business, social and labour relations, and the management of their generation and distribution is highly dynamic, albeit uneven in sectoral and country terms. the leaders are the financial sector and highly developed countries, with increasing cross-sectoral and cross-country diffusion at the global level.

A sufficiently representative, annually updated information base for the development of the digital economy is provided mainly by specialised indices of international organisations and private agencies. The problem of incomplete,

[33] Anders Indset. Quantum Economics / translated from German by O. Vankevych and S. Sviatenko. Kyiv: ArtHuss, 2021. 256 p. [In Ukrainian]
[34] Ibid.
[35] Skinner Chris. Digital Man / translated from English by G. Yakubovska. Kharkiv: Ranok Publishing House: Fabula, 2020. 272 p. [In Ukrainian]
[36] The Phenomenon of Neoliberalism: Ideological Senses: A Monograph: Second edition, supplemented. Ternopil: Kryla Publishing House, 2023. 272 p. [In Ukrainian]
[37] Smil Vaclav. How the world really works. Past, present and future from the point of view of science / translated from English by Alexander Stukalo. 2nd ed. K.: Laboratory, 2023. 312 p. [In Ukrainian]

fragmented and unreliable information for scientifically based analysis and monitoring of the process of formation and functioning of digital economies can be solved only by a systematic approach, with multichannel sources of information not only national and sectoral statistics, administrative, corporate and personal reporting, but also big data (telecommunications operators, cash registers, social networks, digital platforms).

The digitalisation of the economy has led to the emergence of the newest segments of the global economy – the Internet economy, the electronic economy, the platform and network economies, and in the future, the virtual economy and the artificial intelligence economy and the smart economy. Such an understanding of economies is increasingly being integrated into the smart economy, which is currently an obvious but not fully researched and therefore insufficiently identified phenomenon. Smart businesses, cities, and communities are becoming unique enclaves of the global economy with fundamentally different living conditions from traditional ones, which require an impartial systemic analysis, especially with regard to cyber risks.

The discovery of new strategic opportunities and the justification of priorities for Ukraine's digital development should be focused on solving key tasks in this area, primarily of the European Union, which requires not only the implementation of relevant regulations and standards, but also the direct introduction of the latest technologies and business models in the process of post-war modernisation on an innovative basis.

** This article was translated from its original in Ukrainian*

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