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DYNAMICS OF DIGITAL TRANSFORMATIONS IN THE NATIONAL ECONOMY OF UKRAINE

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Abstract. *The purpose* of the paper is to analyse the quantitative changes dynamics in the development and application of information and communication technologies in production and sale of information, traditional goods and services, provision of public services, as well as in everyday life of citizens. *Methodology*. The main method of research is the trend analysis of statistical data provided on the official website of the State Statistics Service of Ukraine. *Results* of the survey showed dynamics of digital transformations in the information sector of national economy of Ukraine, the level of use of information and communication technologies by enterprises outside the information sector, as well as the population and government agencies (2016–2019). *Practical implications.* Positive and negative changes in the information sector because of digital transformations in national economy of Ukraine are found. There are positive changes: annual growth of the information sector; growth of production volumes with the use of medium-high technologies; increase in sales of services with computer equipment; level of use of fixed broadband Internet access by enterprises higher than the average; positive dynamics of Internet use by the population; availability of Internet access in 94% of surveyed government agencies. There are negative changes: reduction of indicators of the use of information and communication technologies at the enterprises outside information sector; insufficient provision of enterprises with specialists in information and communication technologies; a small number of companies with official website and cloud technology; low indicators of e-business development according to the B2B interaction model; lack of generally accepted methodology and list of evaluation indicators; unsatisfactory level of collection, grouping and provision of statistical data about dynamics of digital transformations of the national economy by the State Statistics Service of Ukraine; unsatisfactory level of use of e-democracy instruments. *Value/originality*. The findings can be used to improve the mechanisms and measures of state regulation of digitalization of the national economy.

Key words: digital transformations, information sector, information and communication services, website, cloud technologies, e-business, e-democracy instruments.

JEL Classification: E26, O33, O38

1. Introduction

The rapid development of current technologies has a positive impact on the development of national economies to achieve their Sustainable Development Goals. Nowadays, one of the main problems is to ensure the effective integration of the introduction of information and communication technologies (ICT) with the interests of key stakeholders in development processes: enterprises, individuals and government organizations. Timely identification of the shortcomings of such integration should be a priority for relevant government agencies and NGOs.

The use of digital technologies provides significant benefits: for companies – to increase productivity and competitiveness, for people – to acquire new knowledge and skills, job choices and opportunities, for governments – to improve the quality of public services to citizens and organizations. Countries are able to reap the full benefits of ICT transformation if they continually improve the business climate, invest in education and public health, and promote good governance. Countries that complement investment in new technologies with large-scale economic reforms receive digital dividends by accelerating economic growth, increasing jobs and improving the quality of services. Such reforms include improving the regulatory framework that allows organizations to use the Internet for competition and innovation, bringing employees up to the demands of new economy, enabling people to take full advantage of digital technologies, and ensuring accountability of institutions to ensure rapid needs and requirements of citizens.

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As digital transformation extends to all sectors and affects all aspects of society, measuring its individual characteristics and dynamics will become an increasingly difficult task to answer a wide range of questions, including how to measure and track digital transformations in all sectors of national economy, including the public sector; how to measure the destruction of existing business models and the emergence of new ones, the reorganization of the work or the size of the structural components of national economy; how to assess the value of data, both private and public, in standard statistics; how to track international transactions of digitized goods and services; how policies affect the digital economy and how to monitor and evaluate such impacts; what economic activities and jobs should appear in the future; what is the impact of digital transformations on the well-being of citizens and society as a whole.

Nowadays, information and communication technologies and digital transformation are the driver of technological change and a condition for national economy competitiveness and sustainable development. To increase the competitiveness of national economy, it is necessary to accelerate the start of digital transformation.

2. Survey recent research

The results, risks and benefits of ICT introduction in production and sale of traditional goods and services are surveyed by many Ukrainian and foreign researchers and scientists. The areas of such research are: analysis of the level of digitalization of Ukraine and the European Union (Karchev, Ohorodnia, Openko, 2017), analysis of the most famous indices to reflect level of digital transformation of national economies (Pizhuk, 2019; Yanenkova, 2017), selection of a group of indicators to analyse level of formation and development of digital economy (Semenog, 2020), development of methods to determine integrated indicators of condition and potential of digital development of the national economy (Kuzovkova, Salutina, Kukharenko, 2019), methods of calculating the International Digital Economy and Society Index (I-DESI, 2020), the Digital Economy and Society Index (DESI), the Network Readiness Index (2019).

However, currently there is no universal method of analysing these processes. The study of the dynamics of change on international indices does not always reflect the real transformations in a national economy. Therefore, we consider carrying out a trend analysis of the dynamics of digital transformations of the national economy. On the basis of statistical reporting, we should identify "bottlenecks" and positive changes in these processes.

3. Methodology of digital transformations

The study of the dynamics of digital transformations of the national economy requires defining the main components (parameters) and indices (indicators) of evaluation. There is currently no generally methodology and list of indicators. Thus, R. Kling and R. Lamb in their work (Kling, Lamb, 2000), based on the publication of L. Margherio et al. (Margherio, 1999), identified four main components of the digital economy: (1) digital products and services (access to information services, software sales, e-education, etc.); (2) mixed digital products and services (retail sale of real goods, hotel rooms, as well as related sales and marketing); (3) services and production of goods depended on information technology (accounting services, production of real goods, which require high-precision machining using software control, etc.); (4) products and services of the information sector (production of network equipment and personal computers, information consulting, etc.).

In "Measuring The U.S. Digital Economy: Theory and Practice", Thomas L. Mesenbourg and B. K. Atrostic (Mesenbourg, Atrostic, 2001) identified the following main components of digital economy: supporting infrastructure (hardware, software, telecommunications, networks), electronic business processes (characteristics of doing business), and e-commerce operations (sale of goods and services via the Internet).

Recently, the following international indices have become widespread and popular: the level of ICT development and use is determined by the Digital Economy and Society Index (DESI), the International Digital Economy and Society Index (I-DESI) (2020), and the Network Readiness Index (NRI) (2019), etc. The methodology for calculating the final indicator for each of these indices involves the selection of certain parameters and indicators of evaluation. The list of these parameters and indicators differs. The general evaluation parameters are: quality of fixed and mobile broadband communication, digital skills of the population, directions of the Internet use, development of sales channels via the Internet, digital government services.

To analyse the dynamics of digital transformations in the national economy of Ukraine, we use official statistical reporting and observations data of the State Statistics Service of Ukraine official website. It should be noted that most of the digital information on the level of ICT use is in "Information Society" section. However, data on the development of information sector of Ukrainian economy, the use and growth of the technologies market of varying complexity, the sale of goods and services using ICT are in "Activities of enterprises" section; data on exports and imports of services in telecommunications, computer and

information services are in "Foreign economic activity" section; data on the use of the Internet by the population are on the website of the Internet Association of Ukraine in the section "Projects. Internet audience research."

The concept of "digital transformation" includes quantitative changes in the development and application of ICT in production of information and traditional goods and services, public services, as well as in the citizens' everyday life. Thus, the analysis of the dynamics of digital transformations involves identifying both positive and negative changes in functioning of information sector of the national economy, level of ICT use by enterprises, individuals and government agencies. The analysis uses 2016–2019 period according to the periodicity of updating statistical data on the official website of the State Statistics Service of Ukraine.

4. Information sector in Ukraine

The information sector of national economy consists of manufacturers of network equipment and personal computers, as well as firms that provide consulting services IT consulting. In 2016–2019, the number of enterprises operating in this sector (by 20% during the period), the number of employees of these enterprises (by 17.5%) and the volume of products sold by them (twice) steady increased (Table 1).

The highest growth rate is for production using medium-high technologies (+55%); the lowest one is for production using high technologies (+30%). The latter includes: computer linguistics and computer science (formalization of problems and tasks that are similar to human actions (artificial intelligence)); data exchange between the physical world and computer systems using standard communication protocols (Internet of Things); merger of automated production, data exchange and production technologies into a single self-regulatory system with minimal or no human intervention (Industry 4.0); standalone devices; quantum computers; virtual reality, communication and 5G networks; blockchain, etc.

The reduction in the number of employees in enterprises that use high (-7%), medium-high (-2.6%) and medium-low production technologies (-4.3%) is concerned (Table 2).

There are different reasons of reduction by various factors. The positive factors are increasing the share of automated work, optimization of business management processes, expanding the content of individual employees. The negative factors are unsatisfactory level

Table 1

Quantitative characteristics of the development of information sector of Ukraine in 2016–2019

Indicators	Years				Growth rate 2019 / 2016, %
	2016	2017	2018	2019	
Information sector					
number of enterprises, units	4 866	5 272	5 495	5 848	+20.2
number of employees, persons	50 289	56 838	57 416	59 102	+17.5
volume of sales, thousand UAH	17 980 705	23 187 133	29 024 539	36 118 468	+100.9

Source: Performance indicators of enterprises, State Statistics Service of Ukraine (2010–2019)

Table 2

The dynamics of using technologies of different levels of complexity in 2016–2019

Indicators	Years				Growth rate 2019/2016, %
	2016	2017	2018	2019	
Production on high technologies using					
number of enterprises, units	916	961	1 001	1 040	+13.5
number of employees, persons	103 351	103 115	95 706	95 793	-7.3
volume of sales, thousand UAH	57 556 690	68 846 165	75 731 614	74 890 274	+30.1
Production on medium-high technologies using					
number of enterprises, units	4 895	5 337	5 647	5 931	+21.2
number of employees, persons	356 219	358 760	360 601	346 833	-2.6
volume of sales, thousand UAH	183 971 302	214 800 925	265 644 383	285 409 769	+55.1
Production on medium-low technologies using					
number of enterprises, units	12 468	13 485	14 036	14 799	+18.7
number of employees, persons	441 371	432 909	434 703	422 536	-4.3
volume of sales, thousand UAH	549 233 106	726 062 021	880 188 463	804 372 660	+46.5
Production on low-level technologies using					
number of enterprises, units	14 156	15 414	16 178	17 005	+20.1
number of employees, persons	528 683	550 213	558 281	547 976	+3.6
volume of sales, thousand UAH	638 848 863	771 463 009	839 602 340	860 556 954	+34.7

Source: Performance indicators of enterprises, State Statistics Service of Ukraine (2010–2019)

of wages, late payment of wages, unsatisfactory working conditions, and the use of imperfect management instruments. However, under the growth in sales staff reductions lead to an increase in productivity indicator, which is certainly a positive phenomenon.

5. Dynamics of ICT

The vast majority of ICT is used in services (97% in 2019). The total growth of sales of services provided using ICT during the period is 76% (Table 3).

Simultaneously, the level of ICT use in goods production also has a positive trend under the growth of number of enterprises and sales.

In 2016–2019, there are the most significant quantitative changes in sales occurred in services related to the use of computer equipment (93.5%), which include: computer programming services, development of the structure and content of the web-sites, development of the structure and content of databases, design and development of applications, configuration and implementation of the software application so that it operates within the information system of the client. Also, a significant increase (71.2%) is in the volume of services using high technologies (Table 4).

The dynamics of indicators of ICT use at Ukrainian enterprises outside information sector is mostly negative in study period. Thus, number of enterprises used computers decreases in 7.2 p.p.; number of enterprises with Internet access decreases in 11.8 p.p.; the average number of employees who used computers with Internet access decreases in 50.7 p.p.; the number of enterprises using local computer networks, Intranet and Extranet decreases in 7.6, 4.4 and 0.7 p.p. respectively (Table 5).

The share of enterprises using fixed broadband Internet access in 2016–2019 is over 60%. Simultaneously, there is an annual reduction of the indicator (Table 6).

The share of enterprises that has an official website ranges from 35.2 to 38.4% in 2016–2019. In 2019,

Table 3
The dynamics of using information and communication technologies in 2016–2019

Indicators	Years				Growth rate 2019/2016, %
	2016	2017	2018	2019	
Information and communication technologies					
number of enterprises, units	9 979	11 271	12 291	13 521	+35.5
number of employees, persons	132 158	128 973	127 941	136 485	+3.3
volume of sales, thousand UAH	150 681 907	188 042 533	230 821 579	261 481 025	+73.5
in particular: information and communication technologies in production					
number of enterprises, units	286	285	293	320	+11.9
number of employees, persons	11 004	10 670	10 341	10 406	-5.4
volume of sales, thousand UAH	6 349 731	6 637 844	8 588 477	7 497 364	+18.1
information and communication technologies in services					
number of enterprises, units	9 693	10 986	11 998	13 201	+36.2
number of employees, persons	121 154	118 303	117 600	126 079	+4.1
volume of sales, thousand UAH	144 332 172	181 404 689	222 233 103	253 983 661	+76.0

Source: Performance indicators of enterprises, State Statistics Service of Ukraine (2010–2019)

Table 4
The growth rate of the market for services using high technologies in 2016–2019

Indicators	Years				Growth rate 2019/2016, %
	2016	2017	2018	2019	
Services using high technologies					
number of enterprises, units	13244	14806	15859	17173	+29.7
number of employees, persons	260318	259184	255681	256276	-1.6
volume of sales, thousand UAH	127359909	150459570	185176262	218065820	+71.2
Intellectually rich market services					
number of enterprises, units	64969	72331	77135	83254	+28.1
number of employees, persons	577084	563537	551099	604961	+4.8
volume of sales, thousand UAH	398904519	476283697	544879427	588633439	+47.6
Services using computer equipment					
number of enterprises, units	5350	6264	7003	8063	+50.7
number of employees, persons	44939	47177	49533	58099	+29.3
volume of sales, thousand UAH	48660282	60826902	76545025	94175579	+93.5

Source: Performance indicators of enterprises, State Statistics Service of Ukraine (2010–2019)

Table 5
The indicators of the use of information and communication technologies at the enterprises of Ukraine in 2016–2019

Indicators	Years				Deviation 2019/2016, p.p.
	2016	2017	2018	2019	
Number of enterprises using computers, in % of total number of enterprises	95.1	95.4	89.7	87.9	-7.2
Average number of employees who used computers, in % of total number of employees	30.9	34.9	32.8	34.3	+3.4
Number of enterprises with Internet access, in % of total number of enterprises	98.2	98.2	88.0	86.4	-11.8
Average number of employees who used computers with Internet access, in % of total number of employees	79.1	72.2	27.1	28.4	-50.7
Number of enterprises that:					
uses a local area network (LAN),%	59.5	62.0	53.5	51.9	-7.6
has an Intranet,%	62.4	67.0	59.2	58.0	-4.4
has an Extranet,%	8.8	8.0	8.3	8.1	-0.7

Source: The use of information and communication technologies at enterprises, State Statistics Service of Ukraine (2016, 2017, 2018–2019)

Table 6
The number of enterprises using high-speed Internet access in 2016–2019

Indicators	Years				Deviation 2019/2016, p.p.
	2016	2017	2018	2019	
Number of enterprises using narrowband access, %	31.3	32.9	31.4	30.6	-0.7
Number of enterprises using fixed broadband access, %	67.1	66.3	62.1	60.9	-6.2
Number of businesses using mobile broadband with portable devices, %	23.4	24.1	23.5	23.6	+0.2

Source: The use of information and communication technologies at enterprises, State Statistics Service of Ukraine (2016, 2017, 2018–2019)

Table 7
The main areas of use of websites by Ukrainian enterprises in 2016–2019

Indicators	Years				Deviation 2019/2016, p.p.
	2016	2017	2018	2019	
Number of enterprises with website, in % of total number of enterprises, in particular the website provided an opportunity:	37.5	38.4	35.6	35.2	-2.3
customer service	17.3	17.6	16.9	16.7	-0.6
product supply	6.2	6.6	6.3	6.1	-0.1
order goods and services online	10.2	10.5	10.3	10.2	0
links to company profiles on social media	14.8	16.2	16.2	16.5	+1.7
providing information on open vacancies	10.0	10.8	10.5	10.4	+0.4
personnel training	3.6	3.8	3.9	3.9	+0.3

Source: The use of information and communication technologies at enterprises, State Statistics Service of Ukraine (2016, 2017, 2018–2019)

the indicator decreases in 2.3 p.p. compared to one in 2016. The most common website options are customer service and links to company profiles on social networks, the least common – staff training (Table 7). Fluctuations in the relative use of websites can be considered insignificant.

The use of cloud technologies can be considered insufficient: only 8.8-10.3% of enterprises purchase the relevant services. There are reasons for the slow spread of cloud technologies: problems with secure transmission and storage of data, the need for a constant connection to the Internet, the risk of information loss. However, the indicator has a positive trend (Table 8).

Indicators of e-business development by the "B2B" interaction model are insignificant. Thus, the share of enterprises purchasing goods or services via the Internet ranges from 17.2 to 20.3% (Table 9). The overall dynamics of the indicator is positive but insignificant one (an increase of 2.9 p.p.).

The share of enterprises receiving orders via the Internet for the sale of goods or services ranges from 4.8 to 6.4% and decreases over the period by 1.2 p.p. The largest share of products sold through websites or applications is 4.5% of total sales of enterprises. It is considered a very low figure.

The dynamics of indicators of the Internet use by the population in 2016–2019 is insignificant, but

Table 8
The dynamics of use of cloud technologies by Ukrainian enterprises in 2016-2019

Indicators	Years				Deviation 2019/2016, p.p.
	2016	2017	2018	2019	
Number of enterprises that purchases cloud computing services, in % of total number of enterprises	8.8	9.8	9.8	10.3	+1.5
Number of enterprises that analyses the "big data" from smart devices or sensors, %	8.6	7.6	5.9	5.7	-2.9
The number of companies that analyses the "big data" from portable geolocation devices, %	3.5	3.7	3.4	3.7	+0.2
Number of enterprises that analyses the "big data" from social media, %	4.1	3.9	3.3	3.3	-0.8

Source: The use of information and communication technologies at enterprises, State Statistics Service of Ukraine (2016, 2017, 2018–2019)

Table 9
The dynamics of e-business development in Ukraine in 2016–2019

Indicators	Years				Deviation 2019/2016, p.p.
	2016	2017	2018	2019	
Number of enterprises purchasing goods or services via the Internet, in % of total number of enterprises	17.2	20.3	19.5	20.1	+2.9
Number of enterprises receiving orders via the Internet for the sale of goods or services, in % of total number of enterprises	6.0	6.4	50	4.8	-1.2
Volume of sold products (goods, services) receiving from trade through websites or applications (applications), in % to total volume of sold products (goods, services) of enterprises	…	…	3.5	4.5	-

Source: The use of information and communication technologies at enterprises, State Statistics Service of Ukraine (2016, 2017, 2018–2019)

positive one (Table 10). The highest growth rate in 2019 is the number of regular Internet users (7 p.p.). Simultaneously, mobile phones or smartphones and home laptops are mostly used as technical devices by regular users to access the network. Residents of cities with a population of less than 100,000 in 2019 account for 29% of total number of Internet users. The same share falls on rural residents.

The distribution of network users by regions of the country in 2019 is: the Central-Northern regions of Ukraine – 33%, the Eastern regions – 29%, the Western regions – 27%, the Southern regions – 11%. The most numerous age groups among Internet users are people aged 25-34 years (25%) and aged 35-44 years (21%).

6. E-democracy instruments

The analysis of the dynamics of indicators of the use of e-democracy instruments by public authorities and local governments due to the lack of data for the study period is impossible. The website of the State Statistics Service of Ukraine shows the results of the survey for 2019 only. They show that more than 94% of surveyed government agencies have Internet access and only about 22% of them provides citizens with e-democracy instruments such as "E-appeal", "E-petition", "E-consultation", "Participation budget (public budget)" (Table 11).

Since 2018, the Center for Innovation Development conducts a study of the Local e-Democracy Index on the following indicators: democratic regulations,

Table 10
The dynamics of indicators of the Internet use by population in 2016–2019

in %

Indicators	Years				Deviation 2019/2016, p.p.
	2016	2017	2018	2019	
Availability of Internet at home	61.3	63.4	65.0	65.0	+4.7
Share of regular users	64.0	64.1	63.0	71.0	+7.0
Internet penetration by types of settlements: cities with a population of 100 thous.+	71.0	77.0	71.0	74.0	+3.0
cities with a population of 100 thous. –	66.0	67.0	63.0	70.0	+4.0
villages	54.0	53.0	53.0	58.0	+4.0

Source: Internet Audience Research

Table 11

The indicators of the use of e-democracy instruments in 2019

Indicators	Total	Of them			
		public authorities	bodies of judicial system	local governments	state organizations (institutions, establishments)
Number of institutions with the Internet access, units	17678	5102	695	10584	1297
Share of institutions with Internet access in total number of institutions of survey, %	94.7	92.5	87.9	96.6	92.8
Number of institutions providing the opportunity to use of e-democracy instruments, units	3853	1326	568	1818	141
in% to total number of institutions with Internet access	21.8	26.0	81.7	17.2	10.9

Source: Use of E-democracy instruments by Public authorities and Local governments (2019)

availability of IT instruments, number and percentage of unique active users, number of created cases, number of considered cases, number of supported cases, number of completed cases, percentage of completed cases, duration of execution. In 2017, the top three cities includes Kyiv, Khmelnytsky and Vinnytsia (Prykhodko, Yemelianova, Loboiko, Khutkyi, Kushnirenko, 2018), in 2018 the leaders are Kyiv, Ivano-Frankivsk and Lviv (Yemelianova, Loboiko, Maievska, 2019).

On the surveys and measurements, the authors of the reports identify the following shortcomings in the use of e-democracy instruments: inaccessibility to platform administrators from the local government of statistical indicators on attendance, number of registered users, etc.; lack of information from local governments on the effectiveness of e-petitions and e-consultations made it impossible to consider them in local policies; closeness of e-democracy instruments for cooperation with IT volunteers and further improvement.

6. Conclusions

The analysis of the dynamics of digital transformations of national economy of Ukraine in 2016–2019 reveals the positive changes as: annual growth of the information sector, growth of production using medium-high technologies, significant quantitative changes in sales of services related to computer equipment; the share of enterprises using fixed broadband Internet access is over 60%; positive dynamics of Internet use by the population, availability of the Internet in 65% of households, growth in the share of regular network users; availability of Internet access in 94% of surveyed government agencies.

There are some negative changes: reduction of information and communication technologies in enterprises outside information sector; low level of enterprises with an official website and cloud technologies; insignificant indicators of e-business development according to the "B2B" interaction model; a low share of public institutions providing citizens with the opportunity to use the e-democracy instruments. Also, the negative aspects of the analysis of the dynamics of digital transformations are: the lack of a common methodology and list of evaluation indicators; unsatisfactory level of collection, grouping and provision by the State Statistics Service of Ukraine of statistical data characterizing the dynamics of digital transformations of the national economy.

The further researches include techniques and means to improve the state regulation of digitalization of national economy.

References:

DESI 2020: How digital is Europe compared to other major world economies? Available at: https://ec.europa.eu/digital-single-market/en/news/i-desi-2020-how-digital-europe-compared-other-major-world-economies (accessed 02 November 2020).

Digital Agenda Key Indicators. Available at: https://digital-agenda-data.eu/datasets/digital_agenda_scoreboard_key_indicators (accessed 02 November 2020).

Internet audience research. Available at: https://inau.ua/proekty/doslidzhennya-internet-audytoriyi (accessed 02 November 2020).

Karcheva, H. T., Ohorodnia, D. V., & Openko, V. A. (2017). Digital economy and its impact on the development of national and international economy. *Financial space,* no. 3(27), pp. 13–21. (in Ukrainian)

Kling, R., & Lamb, R. (2000). IT and Organizational Change in Digital Economies. *Understanding the Digital Economy* (E. Brynjolfsson, B. Kahin (eds)). Cambridge: MIT Press, MA, pp. 295–324.

Kuzovkova, T. A., Salutina, T. Yu., & Kukharenko, E. G. (2019). Methodological foundations and results of an integral assessment of digital development of economy and society. *Electronic scientific journal "Age of Quality",* no. 3, pp. 106–122. Available at: http://www.agequal.ru/pdf/2019/319007.pdf (accessed 02 November 2020). (in Ukrainian)

Margherio, L. et al. (1999). *The Emerging Digital Economy*. Washington, DC: Department of Commerce. Available at: http://www.esa.doc.gov/sites/default/files/emergingdig_0.pdf (accessed 02 November 2020).

NRI 2019 Analysis. The Redesigned NRI Model. Available at: https://networkreadinessindex.org/2019/nri-2019-analysis/#renewed-model (accessed 02 November 2020).

OECD. Classification of manufacturing industries into categories based on R&D intensities/2011/. Available at: https://www.oecd.org/sti/ind/48350231.pdf (accessed 02 November 2020).

Performance indicators of enterprises grouped by special aggregations (2010–2019). Available at: https://ukrstat.org/uk/operativ/menu/menu_u/sze_20.htm (accessed 02 November 2020).

Pizhuk, O. I. (2019). Modern methodological approaches to assessing the level of digital transformation of the economy. *BUSINESS INFORM,* no. 7, pp. 39–47. Available at: https://www.business-inform.net/export_pdf/business-inform-2019-7_0-pages-39_47.pdf (accessed 02 November 2020). (in Ukrainian)

Prykhodko, Kh., Yemelianova, A., Loboiko, S., Khutkyi, D., & Kushnirenko, T. (2018). *Indeks mistsevoi elektronnoi demokratii v Ukraini: pilotne doslidzhennia* [The Local Electronic Democracy Index in Ukraine: A Pilot Study]. Kyiv: Innovation Development Center. Available at: https://cid.center/wp-content/uploads/2019/09/E-Dem-Index-2018.pdf (accessed 02 November 2020). (in Ukrainian)

Semenog, A. Yu. (2020). Analysis of world ratings for formation and development of digital economy and Ukraine's place. *Scientific Bulletin of the International Humanities University. Series: Economics and Management*, vol. 43, pp. 38–43. DOI: https://doi.org/10.32841/2413-2675/2020-43-6. Available at: http://www.vestnik-econom.mgu.od.ua/journal/2020/43-2020/8.pdf (accessed 02 November 2020). (in Ukrainian)

The use of e-democracy instruments by public authorities and local governments in 2019. Available at: http://www.ukrstat.gov.ua/ (accessed 02 November 2020).

The use of information and communication technologies at enterprises in 2018–2019. Available at: https://ukrstat.org/uk/operativ/operativ2018/zv/ikt/arh_ikt_u.html (accessed 02 November 2020).

The use of information and communication technologies at enterprises in 2017. Available at: https://ukrstat.org/uk/operativ/operativ2018/zv/ikt/arh_ikt_u.html (accessed 02 November 2020).

The use of information and communication technologies at enterprises of Ukraine in 2016. Available at: https://ukrstat.org/uk/druk/publicat/kat_u/publinform_u.htm (accessed 02 November 2020).

The volume of services sales in telecommunications and postal services field. Available at: http://www.ukrstat.gov.ua/ (accessed 02 November 2020).

Thomas, L. Mesenbourg, B. K. Atrostic Measuring *The U.S. Digital Economy: Theory and Practice*. Available at: https://2001.isiproceedings.org/pdf/1074.PDF (accessed 02 November 2020).

Yanenkova, I. H. (2017). Digital transformation of Ukrainian industry: key highlights. *Problems economy*, no. 4, pp. 179–184. Available at: https://www.problecon.com/export_pdf/problems-of-economy-2017-4_0-pages-179_184.pdf (accessed 02 November 2020). (in Ukrainian)

Yemelianova, A., Loboiko, S., & Maievska, O. (2019). *Indeks mistsevoi elektronnoi demokratii v Ukraini* [The Local e-democracy Index in Ukraine]. Kyiv: Innovation Development Center. Available at: https://cid.center/wp-content/uploads/2019/12/e-dem-index-2.0.pdf (accessed 02 November 2020). (in Ukrainian)