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UKRAINE IN THE INFORMATION AND COMMUNICATION TECHNOLOGY DEVELOPMENT RANKING. I

This article considers the level and evolution of information and communication technology developments in Ukraine and its experience relative to other Eastern European and post-Soviet countries based on the Information and Communication Technology Development Index over 2002–2017. Also modeling of the indicators characterising the development of information and telecommunication technologies in Ukraine will be done.

Keywords: *Information and Communication Technology Development Index, digital divide, global development indices, Digital Agenda of Ukraine.*

Introduction

On January 17 2018 the government of Ukraine passed its Decree № 67-p “About Adoption of the Concept for Development of Digital Economy and Society for 2018–2020“ and approved a plan of steps to put the Concept into practice. The Ministry of Economic Development and Trade is appointed to be responsible for the fulfilment of this program. The main goal of this document is to see fulfilled the initiatives of the “Digital Agenda of Ukraine 2020” (Digital Strategy) to remove barriers on the way of digital transformation of Ukraine in the most prospective fields [1, 2].

According to the decree, putting into practice the measures of this concept should help to stimulate economic development, and to attract investments, to make Ukrainian industry com-

petitive and efficient thanks to its “digitalization”. Furthermore it aims to decrease “digital divide”, bring digital technologies closer to people, create new opportunities for human capital realization, develop innovative, creative and digital industries and businesses and to promote export of digital products and services (IT outsourcing).

Along with these main goals the “Digital Agenda of Ukraine 2020” also proclaims so called rating goals based on the global development indices, that is to become № 40 in the Networked Readiness Index Rating by 2020 (Ukraine is on the 64 position by this index in 2016), № 40 in the Global Innovation Index Rating (Ukraine is № 56 there in 2016), № 50 in the Global Competitiveness Index Rating (Ukraine is № 85 there in 2016, the index is cumulative).

Also it should be added that every country defines the global development indices on which its rating goals are based according to its national strategies, priorities and preferences. For example, the Russian Federation included its position in the rating based on the Information and the Communication Technology Development Index built by the International Telecommunication Union into the set of control indicators of the “Information Society Development Strategy in the Russian Federation” and the State Program “Information Society in 2011–2020” [3, 4].

Kazakhstan also includes the Information and Communication Technology Development Index in its State Program “Digital Kazakhstan” adopted 12.12.2017 along with the E-government development rank and the Global Cybersecurity Index as a target indicator of digital transformation [5].

Since both Kazakhstan and the Russian Federation are among those countries which have achieved a remarkable progress in information technology development during in the resent decade it’s also important to take into account their experience. [6]

Problem Setting

In order to analyze the potential of Ukraine in order to achieve the rating goals defined in the “Digital Agenda of Ukraine 2020”, it is necessary to track the progress of Ukraine in global ratings from their first measurements till the last studies. There are also other important global indices that describe the level of development of information and communication technologies in the world. Since information and communication technologies are the base of the digital economy it is important to make a research of the progress of Ukraine in all these ratings for a better understanding of the prospect of digital economy and its instruments in Ukraine.

The ratings developed by the specialists of the United Nations (UN), the International Telecommunication Union (ITU), the World Economic Forum (WEF) and the World Bank (WB) are considered to be the most authoritative.

The purpose of this article is to analyze how Ukraine changed its position in the rating based on the Information and Communication Technology Development Index (IDI) built by the ITU. This index is chosen as the first indicator to be analyzed because the components of it haven’t been changed since as of the first report in 2002 till 2017.

The level and evolution over 2002–2017 of ICT developments in Ukraine and its experience, relative to other Eastern European- and post-Soviet countries based on IDI are pioneered in this article. Also for the first time the digital divide, i.e. differences between Ukraine and these countries in terms of their levels of Information and Communication Technology (ICT) development; as well as the development potential of ICTs and the extent to which Ukraine can make use of them to enhance growth and development in the context of available capabilities and skills are examined here, based on the analysis of evolution of IDI sub-indices and its components over 2002–2017, the key features of ICT development in Ukraine in 2016, the telecommunication market in Ukraine over 2014–2016, and the connection between GNI and IDI.

The goal of further studies is to conduct a research of how Ukraine succeeded in the Networked Readiness Index — (NRI) developed by the WEF, the E-government development rank built by the UN, the E-participation index (EPI) also developed by the UN, the Knowledge Economy Index (KEI) by the WB and the Global Innovation Index (GII) developed by Cornell University, INSEAD (European Institute of Business Administration) and the World Intellectual Property Organization.

ICT Development Index — IDI: Conceptual Framework

The ITU Information and Communication Technology Development Index (ICT Development Index, or IDI) brings together indicators concerned with ICT access, use and skills into a single comparative measure of development towards the information society. The IDI is a composite index that combines 11 indicators into one benchmark measure that can be used to moni-

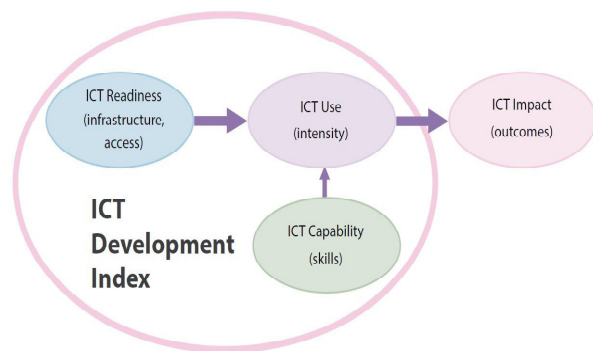


Fig. 1. Three stages in the evolution towards an information society

tor and compare developments in ICTs between countries and over time [7].

The main objectives of the IDI are to measure:

- the level and evolution over time of ICT developments within countries and of their experience relative to other countries;
- progress in ICT development in both developed and developing countries;
- the digital divide, i.e. differences between countries in terms of their levels of ICT development;
- the development potential of ICTs and the extent to which countries can make use of them to enhance growth and development in the context of available capabilities and skills.

The Index is designed to be global and reflect changes taking place in countries at different levels of ICT development. It therefore relies on a limited range of data sets which can be established with reasonable confidence in countries at all levels of development.

The ICT development process, and a country's transformation to becoming an information society, can be depicted using the three-stage model illustrated in Fig. 1.

Based on this conceptual framework, the IDI is divided into the following three sub-indices illustrated with their component indicators in Fig. 2.

The term international Internet bandwidth refers to the total used capacity of international Internet bandwidth, in megabits per second (Mbit/s). The term computer refers to a desktop computer, laptop (portable) computer, tablet or similar handheld devices. Household with a computer means that

the computer is available for use by all members of the household at any time. Data are obtained by countries through national household surveys and are either provided directly to ITU by national statistical offices (NSOs) or obtained by ITU through its own research.

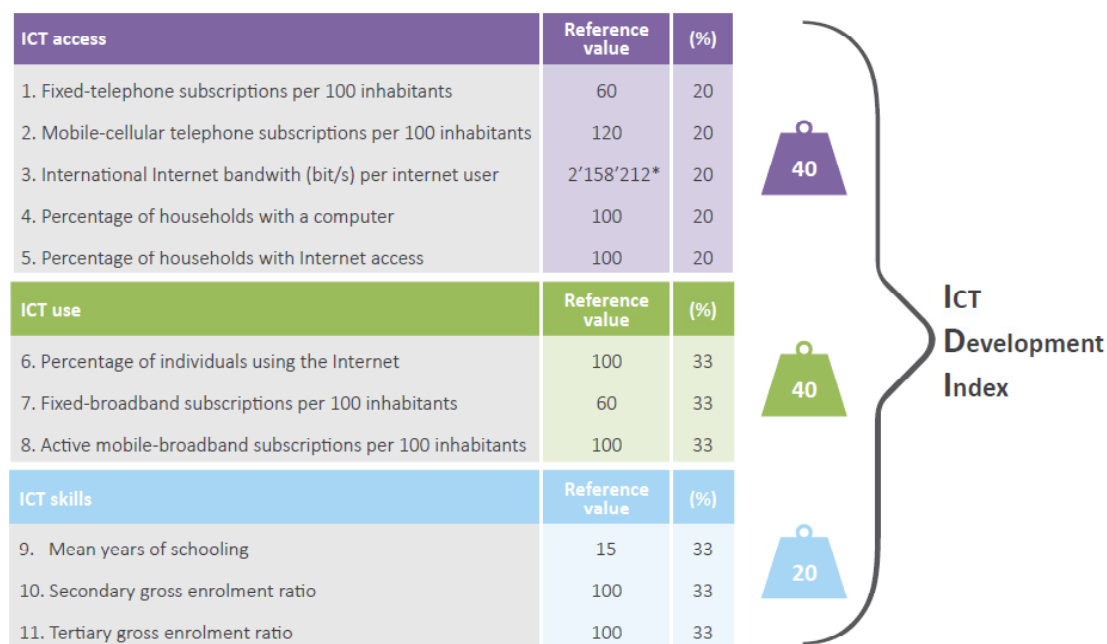
The term individuals using the Internet refers to people who used the Internet from any location and for any purpose, irrespective of the device and network used, in the previous three months. The term fixed-broadband subscriptions refers to fixed subscriptions for high-speed access to the public Internet (a Transmission Control Protocol (TCP)/IP connection) at downstream speeds equal to or higher than 256 kbit/s. The term active mobile-broadband subscriptions refers to the sum of data and voice mobile-broadband subscriptions and data-only mobile-broadband subscriptions to the public Internet. It covers subscriptions actually used to access the Internet at broadband speeds, not subscriptions with potential access. Subscriptions must include a recurring subscription fee to access the Internet. It includes subscriptions to mobile-broadband networks that provide download speeds of at least 256 kbit/s (e.g. WCDMA, HSPA, CDMA2000 1x EV-DO, WiMAX IEEE 802.16 and LTE).

Data on gross secondary and tertiary enrolment ratios are collected by the United Nations Educational, Scientific and Cultural Organization Institute for Statistics (UIS).

Mean years of schooling is the average number of completed years of education of a country's population, excluding years spent repeating individual grades. It is estimated using the distribution of the population by age group and the highest level of education attained in a given year, and time series data on the official duration of each level of education.

According to the UIS, the gross enrolment ratio (secondary and tertiary level) is "the total enrolment in a specific level of education, regardless of age, expressed as a percentage of the eligible official school-age population corresponding to the same level of education in a given school-year."

A number of changes to the IDI will be made with effect of IDI 2018, as a result of decisions taken by an extraordinary meeting of the ITU Expert



Note: * This corresponds to a log value of 6.33, which was used in the normalization step.
Source: ITU.

Fig. 2. ICT Development Index – indicators, reference values and weights

Group on Telecommunication/ICT Indicators and the ITU Expert Group on ICT Household Indicators. The extraordinary meeting adopted a total of 14 indicators to be included in the IDI with effect of IDI 2018, compared with the previous list of 11 indicators. Two existing indicators will be dropped from the IDI (both of which are currently in its access sub-index):

- fixed-telephone subscriptions per 100 inhabitants;
- mobile-cellular subscriptions per 100 inhabitants.

Therefore, the way how Ukraine changed its positions in this ranking during 2002–2017 can be tracked because the changes in the indicators reviewed will be introduced only as of IDI 2018.

Ukraine in the Rating Based on the IDI

Ukraine was referred to as the region of Eastern Europe along with Belarus, Bulgaria, Czech Republic, Hungary, Moldova, Poland, Romania,

Russia, and the Slovak Republic in the first report “Measuring the Information Society 2009”. [8]. Later the authors of the reports rearranged the list of the economies included in the IDI and categorized Ukraine with the group CIS (Commonwealth of Independent States) including Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, and Uzbekistan.

The Commonwealth of Independent States (CIS) is the most homogeneous region in ICT development, reflecting its relative economic homogeneity. Only one country in the region, Belarus, is in the top quartile of the Index. The most dynamic countries in terms of IDI value were those at the bottom of the regional rankings — Ukraine, Uzbekistan and Kyrgyzstan in 2016–2017.

IDI values and rankings for the CIS region are set out in Fig. 3, where they are compared to the global average and with averages for developed and developing countries.

Ten of the 12 countries within the CIS region supply data for the IDI, the exceptions being Tajikistan and Turkmenistan. Four countries in the

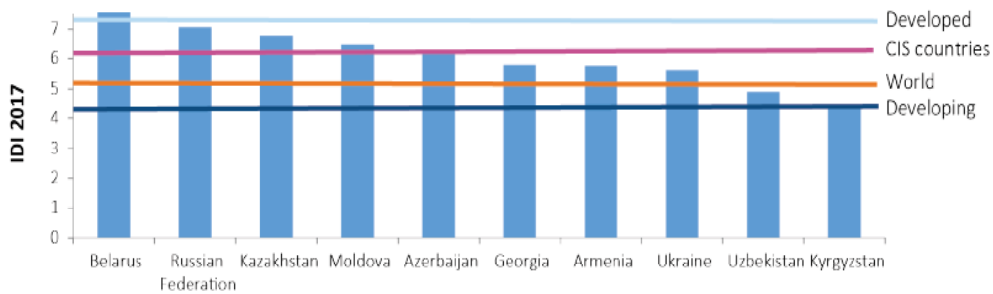


Fig. 3. IDI values, CIS region, IDI 2017

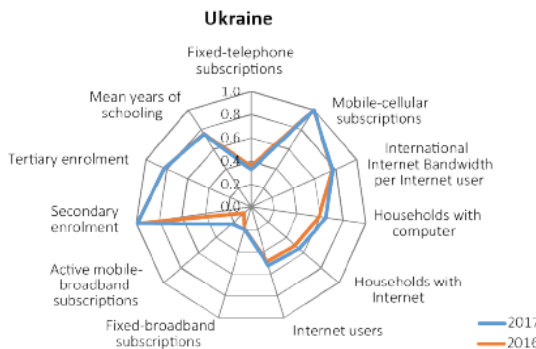


Fig. 4. IDI values, IDI 2017 and IDI 2016

region (Belarus, Moldova, the Russian Federation and Ukraine) are categorized as developed countries, while the remainders are categorized as developing countries. Only one country in the region, Belarus, falls within the high quartile of the IDI for 2017, while a second, the Russian Federation, has slipped from this quartile into top position in the upper-middle quartile, joining six other countries in the region. Two countries (Uzbekistan and Kyrgyzstan) fall into the lower-middle quartile. The biggest improvements were made by Uzbekistan (up 0,42 points), Kyrgyzstan and Ukraine (both up 0,31 points) over 2016–2017. As in most other regions, the most substantial rate of improvement for any individual indicator in the CIS region was the one for mobile-broadband subscriptions, which rose by an average of 31,9 per cent over the year. This indicator rose most substantially – by over 175 percent – in Ukraine in 2016–2017 [9]. The values of all ICT component indicators for Ukraine in 2016 and 2017 are shown in Fig. 4.

The position of Ukraine in both groups in 2002–2017 is shown in Tables 1–4.

Both tables show that Ukraine has worsened its position in comparison with other countries of these groups since 2002. The IDI of Ukraine in 2002 was 2,50, that corresponded to the 59 place in the world’s IDI rating which included 154 countries. Thus Ukraine ranked 8 of 10 Eastern European countries being ahead of Romania (60) and Moldova (74) and 3 of 10 CIS countries being after the Russian Federation (52) and Belarus (57). Ukraine was outrun by Romania in 2007 and by Moldova in 2010. Therefore Ukraine has remained on the bottom of the group of Eastern European countries since 2010. Also in the CIS group Ukraine was overtaken by Kazakhstan in 2010, by Azerbaijan and Armenia in 2012, and by Georgia in 2015. It doesn’t mean that Ukraine didn’t progress in the IDI, in fact it did, because every year its IDI had increased but that progress was too slow in comparison with its neighbouring countries.

Since 2002 the IDI rank of Ukraine has decreased substantially from the 59 rank of 154 countries to the 79 of 176 countries in 2017. This negative trend is even more evident in comparison with other countries from these groups. Belarus increased its rank from 57 in 2002 to 32 in 2017. Thus Belarus becomes a local leader in both Eastern Europe and CIS groups. Also Russia moved from 52 to 45, Moldova from 74 to 59. Therefore, Ukraine found itself on the last position among all 10 Eastern European countries. In the group of CIS countries the situation for Ukraine isn’t better because Azerbaijan achieved an outstanding

Table 1. Value of IDI 2002-2017 of Eastern European countries

Country / Year	Czech Republic	Slovakia	Hungary	Poland	Bulgaria	Russian	Belarus	Ukraine	Romania	Moldova
2002	3,74	3,51	3,49	3,34	2,74	2,71	2,53	2,5	2,48	2,13
2007	4,92	4,86	5,18	4,95	4,42	4,13	3,77	3,56	4,11	3,11
2008	5,42	5,3	5,47	5,29	4,75	4,42	3,93	3,83	4,67	3,57
2010	5,89	5,63	5,53	6,09	4,87	5,61	5,08	4,2	4,89	4,24
2011	6,3	5,85	5,91	6,22	5,5	5,94	5,57	4,38	5,05	4,46
2012	6,4	6,05	6,1	6,31	5,83	6,19	6,11	4,64	5,35	4,74
2013	6,72	6,58	6,52	6,6	6,31	6,7	6,89	5,15	5,83	5,72
2016	7,06	6,84	6,74	6,73	6,66	6,91	7,29	5,31	6,23	6,21
2017	7,16	7,06	6,93	6,89	6,86	7,07	7,55	5,62	6,48	6,45

Table 2. Rank of IDI 2002-2017 of Eastern European countries

Country	Czech Republic	Slovakia	Hungary	Poland	Bulgaria	Russian	Belarus	Ukraine	Romania	Moldova
2002	34	35	36	37	51	52	57	59	60	74
2007	39	41	34	36	43	46	53	58	48	73
2008	37	40	34	41	45	49	58	59	46	64
2010	33	39	42	30	51	40	46	65	50	62
2011	31	40	39	32	47	38	46	69	54	67
2012	34	43	42	37	46	40	41	68	55	65
2013	41	45	46	44	49	42	38	73	58	61
2015	34	47	48	44	50	45	36	79	59	66
2016	39	47	49	50	53	43	32	78	61	63
2017	43	46	48	49	50	45	32	79	58	59

Table 3. Value of IDI 2002-2017 of CIS countries

Country	Russian	Belarus	Ukraine	Kazakhstan	Moldova	Georgia	Armenia	Kyrgyzstan	Uzbekistan	Azerbaijan
2002	2,71	2,53	2,5	2,18	2,13	2,13	2,03	1,97	1,75	1,71
2007	4,13	3,77	3,56	3,17	3,11	2,91	2,66	2,52	2,06	2,71
2008	4,42	3,93	3,83	3,39	3,57	—	2,94	2,62	2,22	—
2010	5,61	5,08	4,2	4,65	4,24	—	—	—	2,77	—
2011	5,94	5,57	4,38	5,41	4,46	—	4,18	—	3,02	—
2012	6,19	6,11	4,64	5,74	5,44	4,48	4,89	3,69	3,27	5,22
2013	6,7	6,89	5,15	6,08	5,72	4,86	5,08	3,78	3,4	5,65
2015	6,91	7,18	5,23	6,2	5,81	5,25	5,32	4,62	—	5,79
2016	6,91	7,29	5,31	6,72	6,21	5,59	5,56	4,06	4,48	6,25
2017	7,07	7,55	5,62	6,79	6,45	5,79	5,76	4,37	4,9	6,2

Table 4. Rank of IDI 2002-2017 of CIS countries

Country	Russian Federation	Belarus	Ukraine	Kazakhstan	Moldova	Georgia	Armenia	Kyrgyzstan	Uzbekistan	Azerbaijan
2002	52	57	59	68	74	75	81	86	98	100
2007	46	53	58	70	73	80	89	96	113	86
2008	49	58	59	72	64	-	86	99	110	-
2010	40	46	65	56	62	-	-	-	104	-
2011	38	46	69	49	67	-	75	-	104	-
2012	40	41	68	48	60	83	73	107	116	65
2013	42	38	73	53	61	78	74	108	115	64
2015	45	36	79	58	66	78	76	97	-	67
2016	43	32	78	51	63	73	74	110	103	60
2017	45	32	79	52	59	74	75	109	95	65

progress, moved from 100 to 65 and Kazakhstan changed from 68 to 52. Also Georgia and Armenia succeeded to outrun Ukraine gotten on the 74 and 75 positions respectively. Therefore, Ukraine only leaves behind Uzbekistan and Kyrgyzstan in the group of CIS countries in 2017.

Summary

Because the methodology of calculating IDI will be changed in 2018, for first time since the initial report “Measuring the Information Society 2009” was published by ITU, it is important to analyze the dynamics of ICT development in Ukraine based on IDI in 2002–2017. Ukraine turned out to demonstrate rather negative dynamics; its progress was too slow especially in comparison with other Eastern European and CIS countries. The country lagged in development of new ICTs when other states benefited of introducing new technologies.

Measuring the evolution of Ukraine in IDI 2002–2017 showed that Ukraine worsened its starting position in IDI 2002, being ranked 8 of 10 Eastern European countries and 3 of 10 CIS countries. In 2017 Ukraine found itself on the bottom of the group of Eastern European countries in 2010 and couldn't improve its position there until now. In the group of CIS countries Ukraine was eventually outrun by all states except Kyrgyzstan

and Uzbekistan. Also it should be added that Azerbaijan, Belarus, Kazakhstan, and the Russian Federation are among the world out-performers in ICT development that managed to achieve a remarkable progress in improving their positions in the ranking based on IDI.

Thus, Ukraine not only was able to decrease its digital divide with Eastern European countries which were the leaders of the IDI 2002, but even more has been outrun by almost all CIS countries by 2017. At the same time Belarus and the Russian Federation managed to leave them behind.

Ukraine belonged to the countries which show significantly better IDI performance than might be anticipated from GNI per capita in 2016. However, Ukraine was outrun by other CIS countries at first in GNI and further in IDI rankings. Moldova is the only exception in this trend because its GNI is still lower than in Ukraine but its IDI has exceeded the IDI of Ukraine since 2010.

Such issues as connection between IDI and GNI, digital divide, the position of Ukraine in the IDI sub-indices, the state of the ICT market in Ukraine, the key ICT development indicators will be considered in the second part of this article. Also modeling of the indicators characterising the development of information and telecommunication technologies in Ukraine will be done.

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УКРАИНА В РЕЙТИНГЕ РАЗВИТИЯ ИНФОРМАЦИОННО-КОММУНИКАЦИОННЫХ ТЕХНОЛОГИЙ. I

Введение. Индекс развития информационно-коммуникационных технологий (ИКТ) - это комплексный, универсальный и общепризнанный показатель, характеризующий достижения страны с точки зрения развития ИКТ. Он рассчитывается Международным союзом электросвязи и избран такими странами как Казахстан и Россия в качестве одного из контрольных для исследования развития ИКТ. Поскольку эти страны достигли значительного успеха в развитии ИКТ за последние годы, то необходимо изучать их подходы к измерению прогресса в этой сфере.

Цель статьи. Для оценки уровня развития и прогресса Украины в развитии ИКТ в сравнении с другими странами Восточной Европы и СНГ проведено исследование того, как Украина меняла свою позицию в рейтинге, разработанном на основе индекса развития ИКТ, в период с 2002 по 2017 годы. Также целью статьи является исследование путей для сокращения цифрового разрыва, т. е. разницы в уровне развития ИКТ, которая возникла между Украиной и другими странами региона, а также изучение потенциала дальнейшего развития ИКТ в Украине и степени, в которой Украина может воспользоваться ими для экономического роста, исходя из имеющихся инфраструктурных, технологических и человеческих ресурсов.

Методы: системный подход, анализ.

Результат. Проведен анализ прогресса Украины в рейтинге, составленном на основе индекса развития ИКТ, в сравнении с другими странами региона, проведено исследование динамики подиндексов индекса развития ИКТ

и их компонентов в 2002–2017 годах, основных характеристик уровня развития ИКТ в Украине на 2016 год, телекоммуникационного рынка Украины в 2014–2016 годах, а также проведено исследование связи между ВНД и индексом развития ИКТ. Построены модели, позволяющие проанализировать развитие информационных и телекоммуникационных технологий в Украине.

Вывод: результаты этого исследования показывают, что с самого начала исследуемого периода, прогресс Украины в развитии ИКТ был очень медленным по сравнению с другими странами региона. Украина отстала от среднего уровня по региону СНГ почти по всем показателям. Однако в последние годы появились положительные тенденции, в частности была введена технология 4G, увеличивается количество пользователей широкополосного доступа, который является основным фактором роста телекоммуникационного рынка. Однако, для быстрого сокращения цифрового разрыва, возникшего между Украиной и ее соседями, нужно еще приложить немало усилий.

Ключевые слова: индекс развития информационных и коммуникационных технологий, цифровой разрыв, показатели глобального развития, цифровая повестка дня для Украины.

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УКРАЇНА У РЕЙТИНГУ РОЗВИТКУ ІНФОРМАЦІЙНО-КОМУНІКАЦІЙНИХ ТЕХНОЛОГІЙ. I

Вступ. Індекс розвитку інформаційно-комунікаційних технологій (ІКТ) – це комплексний, універсальний і загально визнаний показник, що характеризує досягнення країни з точки зору розвитку ІКТ. Він розраховується Міжнародним союзом електрозв'язку. Індекс обраний такими країнами як Казахстан і Росія одним з контрольних для дослідження розвитку ІКТ. Оскільки ці країни досягли значного успіху у розвитку ІКТ за останні роки, то необхідно вивчати їхні підходи до вимірювання змін у цій сфері.

Мета статті. Для оцінювання рівня розвитку і прогресу України у розвитку ІКТ порівняно з іншими країнами Східної Європи і СНГ проведено дослідження того, як Україна змінювала свою позицію у рейтингу, розробленому на основі індексу розвитку ІКТ, у період з 2002 по 2017 роки. Також метою статті є дослідження шляхів для скорочення *цифрового розриву*, тобто різниці у рівні розвитку ІКТ, яка виникла між Україною та іншими країнами регіону, а також вивчення потенціалу подальшого розвитку ІКТ в Україні і ступеня, у якому Україна може скористатися ними для економічного зростання, виходячи з наявних інфраструктурних, технологічних і людських ресурсів.

Методи: системний підхід, аналіз.

Результат. Проведено аналіз прогресу України у рейтингу, складеному на основі індексу розвитку ІКТ, у порівнянні з іншими країнами регіону, проведено дослідження динаміки підіндексів індексу розвитку ІКТ та їх компонентів у 2002-2017 роках, основних характеристик рівня розвитку ІКТ в Україні на 2016 рік, телекомунікаційного ринку України у 2014-2016 роках, а також проведено дослідження зв'язку між ВНД і індексом розвитку ІКТ. Побудовано моделі, які дозволяють проаналізувати розвиток інформаційних і телекомунікаційних технологій в Україні.

Висновок. Результати цього дослідження показують, що з самого початку досліджуваного періоду, прогрес України у розвитку ІКТ був дуже повільним у порівнянні з іншими країнами регіону. Україна відстала від середнього рівня по регіону СНД майже за усіма показниками. Однак, в останні роки з'явилися позитивні тенденції, зокрема була запроваджена технологія 4G, збільшується кількість користувачів широкосмугового доступу, який є основним чинником зростання телекомунікаційного ринку. Однак, для швидкого скорочення цифрового розриву, що виник між Україною та її сусідами, потрібно ще докласти чимало зусиль.

Ключові слова: індекс розвитку інформаційних і комунікаційних технологій, цифровий розрив, показники глобального розвитку, цифровий порядок денний України.