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Analysis of the Digital Readiness and the Level of the ICT Development in Kazakhstan's Regions[1]

The level of digital readiness and the application of information and communication technologies (ICT) are key factors of any innovation policy. This research has highlighted the development of analysis of the degree of digital readiness and assessment methods of digital transformations, which can be used at various levels of business management to formulate digital transformation strategies. The present study investigates the theoretical framework in the field of innovation and spatial development considering the impact of the level of ICT. The research was conducted using index and economic-statistical methods based on a systematic approach. We developed a methodological tool adapted to the regional management level. The ICT development index, Krugman localisation index and Herfindahl-Hirschman index were modified to analyse digital readiness and ICT development at the regional level. The algorithm includes the following steps: assessment of the internet usage level; analysis of the degree of costs for the production of ICT; evaluation of the digital literacy rate of the population; evaluation of the degree of regional industry specialisation in the field of ICT. It was revealed that Kazakhstan's regions have varying levels of ICT development, which is why they have different prerequisites and prospects for digitalising their economy. The agglomerations that could become "growth poles" of Kazakhstan's knowledge-based economy were identified, such as Almaty city, Nur-Sultan city, Karaganda, and Aktobe regions. Government bodies can use the research findings for Kazakhstani territories' digital modernisation.

Keywords: regional development, growth pole, localisation, information technology, innovations, hyper-innovation, digital economy, digital literacy, information flows, information and communication technologies, Kazakhstan

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ИССЛЕДОВАТЕЛЬСКАЯ СТАТЬЯ

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Анализ цифровой готовности и уровня развития информационных и коммуникационных технологий в регионах Казахстана

Ключевыми аспектами инновационной политики являются цифровая готовность и применение информационных и коммуникационных технологий. В статье представлены методы анализа уровня цифровой готовности и оценки цифровых трансформаций, которые могут быть использованы для разработки стратегий цифровой трансформации на всех уровнях управления бизнесом. Теоретические основы в области инноваций и пространственного развития были рассмотрены с учетом влияния информационных и коммуникационных технологий. В исследовании применялись индексный и экономико-статистический методы, опирающиеся на системный подход. Разработанная методика была адаптирована для оценки уровней управления в регионах. Для анализа цифровой готовности и развития информационных и коммуникационных технологий на региональном уровне были использованы модифицированные показатели: индекс развития информационных и коммуникационных технологий, индекс локализации Кругмана и индекс Херфиндаля — Хиршмана. Предложенный в статье алгоритм состоит из следующих этапов: оценка уровня использования интернета, анализ затрат на производство информационных и коммуникационных технологий, оценка уровня цифровой грамотности населения, оценка степени отраслевой специализации регионов в сфере информационных и коммуникационных технологий. Выявлено, что разный уровень развития информационных и коммуникационных технологий в регионах Казахстана влияет на перспективы цифровизации их экономики. Определены агломерации, которые могут стать полюсами роста экономики знаний в Казахстане — г. Алматы, г. Нур-Султан, Карагандинская и Актюбинская области. Полученные результаты исследования могут быть использованы государственными органами Казахстана для цифровой модернизации регионов страны.

Ключевые слова: региональное развитие, полюс роста, локализация, информационные технологии, инновации, гиперинновации, цифровая экономика, цифровая грамотность, информационные потоки, информационные и коммуникационные технологии, Казахстан

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1. Introduction

The effect of COVID-19 on the world economy and the mass closure of borders had a negative impact on many countries, including Kazakhstan. Therefore, it becomes an important task to optimise life in regions and cities. Despite the large number of residents, a certain level of comfort implies the possibility of prompt notification in case of emergencies. Today in many countries, the application of information and communication technologies (ICT) and digital readiness are considered a crucial driver for economic development and a key factor in improving business. Increasing the role of ICT in the public and private sectors is based on the transition to digital transformation.

Thus, Kazakhstan needs to follow the trend of global changes, such as global digitalisation of society, urbanisation, increasing the role of new smart cities with a knowledge-based economy, and reducing social imbalances. Nevertheless, the specificity of raw materials regions of Kazakhstan and many of the Commonwealth of Independent States (CIS) countries does not contribute to the transition to new technological structures.

In this regard, the main prerequisite for conducting this study is the need to analyse the ICT development and determine the level of digital

readiness. The CIS countries should strive to ensure the interaction of national information systems and networks within a single information space.

In recent years, the level of digitalisation of the social sector has been growing. The number of effective ICT applications in the field of accounting for citizens, electronic document management systems (e-government), and control over budget spending increased significantly. The number of databases available to the population through ICT and portals of government agencies also expanded.

However, according to the values of indicators adopted by the UN, the level of digital readiness of national economies remains low. The effectiveness of ICT use in the CIS member countries is constrained by the lack of ICT infrastructure development, especially in remote and hard-to-reach regions. Within the concept of Industry 4.0, full integration of the digital ecosystem is planned, which will cover the whole world.

In this regard, it is necessary to create a new policy of the digital economy for the development of digital infrastructure and digital economy for the CIS countries, including Kazakhstan. In the digital environment, the role and format of traditional academic research, scientific organisations, and universities are changing; new requirements are placed on researchers in regards to their competencies. Therefore, the research on scientific environment readiness to work in the digital economy and the active development of the digital information infrastructure supports the study's relevance and practical importance.

Analysis of digital research models and the level of digital readiness allows establishing the dependence on the prosperity. Over the past ten years, these processes have significantly accelerated: they had a direct effect on economic development and expansion of foreign economic activity, as well as encouraged exchange of information, optimised management and control functions at all levels. Moreover, the processes of the latest information flows and neural network economic revolution are unfolding, transforming traditional economic structure and changing the content of the entire diverse system of socio-economic relations. Thus, Kazakhstan needs to follow the trend of global changes (digitalisation of society, robotics, urbanisation, increasing the role of new types of cities with a knowledge-based economy, reducing social imbalances). At the same time, the raw material specialisation of Kazakh regions and global challenges do not facilitate the transition to new technological modes, hamper the implementation of the "science — education — production" interaction, and do not allow to overcome the fragmented nature of the existing institutional environment and infrastructural support for innovative development.

Hypotheses statement. In this study, we proceeded from the scientific suggestion that digitalisation processes are beginning to develop in Kazakhstan. There are specific sources for the development of ICT in different types of regions. It is evident that the global transition to digital technologies will lead to the transformation of many economic sectors of Kazakhstan and completely change the technological structure. Based on this assumption, we decided that the initial diagnostic algorithm should be based on methodological assessments, which have a quantitative basis by examining the industry specialisation and determining the force of the agglomeration effect. This study is one of the scientific papers that identify the main factors of ICT potential development by assessing the level of the digital readiness of the region.

Thus, this research paper presents tools for assessing the degree of the digital readiness of the regions of Kazakhstan, which can be used at various levels of government to formulate and adjust strategies and plans for digital transformation. Toolkit development and assessment methodology can be used in emerging economies that are ready for digital transformation. The speed, complexity, and scale of the digital changes that are occurring require a specific methodology for assessing digital readiness as a tool for managing change. Based on these suggestions, the methodology is focused on the analysis and evaluation using the algorithm that includes four stages:

1) analysis of the degree of Internet use (share of Internet users);

2) analysis of the degree of costs for the production of ICT;

3) analysis of the digital literacy rate of the population (i. e., public readiness for the global use of ICTs);

4) analysis of the degree of regional specialisation in the field of ICT (identification of promising regions in the field of ICT).

A version of the methodology was developed and adapted to the regional management level. Indicators of industry localisation and specialisation were chosen as methodological assessment tools. Thus, the proposed methodological tools will allow us to conduct a reliable analysis to find the prospects and prerequisites of the territories of Kazakhstan for digitalisation.

In this research, section 2 discussed relevant literature. The methods of scientific research are described in section 3. Section 4 presents an assessment and estimation results. In addition, section 5 offers conclusions.

2. Literature Review

The global transformation and integration of the digital ecosystem will have a global reach soon due to advances in nanotechnology, microelectronics, digital flows, ICT, etc. Thus, the invasion of ICT in society is an inevitable process that can no longer be suspended. Additionally, it will lead to the transformation of digital technologies. The basic premise for the analysis of theoretical views, on the one hand, is the need for high-tech sector development, and, on the other hand, the need to transition from industrial to hyper-innovative development.

The processes of the information and neural network economic revolution are unfolding, leading to the transformation of traditional economy structure and a change in the content of the entire diverse system of social and economic relations. Therefore, among global challenges, two can be distinguished:

— The first task, especially critical for the raw materials regions of Kazakhstan, is the depletion of mineral resources; changing the global energy landscape; strengthening the influence of new technological structures; global digitalisation of advanced industries; replacing management tools for regional development.

— The second task is the transition from a market economy to a management sector based on advanced technologies that are associated with the modification of approaches to scientific and technological development based on the increasing role of ICT, digital transformation, and digital flows.

In the scientific literature on mainstreaming participation of regions and cities of a new type, considering the influence of the digital economy, a wide range of modern approaches is used. At this point, there are no similar views and similar systems of laws of conceptual foundations based on digitalisation in the field of spatial development. Given the importance of the digital economy in influencing regional growth, we conduct a literature study to synthesise numerous detailed observations and assumptions about innovation. Studies show a wide range of ICT effects on economic growth and creating conditions for ensuring the process of initiating regional development (Brynjolfsson, Yang, 1996; Motohashi, 1997; Kraemer, Dedrick, 2001). Thus, some researchers state that there are required multi-level interventions to maintain the ICT services sector's growth trajectory and realise the social and economic benefits associated with the development of a domestically inter-connected ICT sector (Aridi, Hayter, Radosevic, 2021). As for ICT-induced prosperity, there is a need to promote supporting policies in combination with a stable government, adequate funds provision, macro-economic determinants, and an innovative environment to transfer to industry and society (Sarangi, Pradhan, 2020).

Under the institutional approach, the region's innovation system is considered a set of institutions that determine the principles, rules, and methods of implementation of the formation and distribution of innovative products (Quintas, 1994; Christensen, Lundvall, 2004; Afonin, 2007; Kireyeva et al., 2020). Such institutions rely on the system of informal restrictions and formal rules and act as key factors affecting the functioning and development of the innovations and technologies of a region based on clustering (Zubarevich, 2009; Zvereva, Belyaeva, Sohag, 2019).

Innovation shows the process of invention and the creative act during which extended use is carried out. It involves the use of modern ideas to create transformations in the practice of individuals or groups of persons, such as customers or users (Elam, Mead, 1987). A theoretical distinction can be made among product innovations based on new software applications and new software development methodologies, which proceed to process innovations (Carlo, Lyytinen, Rose, 2011).

Finally, innovations are characterised as either sustainable or destructive (Christensen, Overdorf, 2000). Sustainable innovations often help organisations compete within existing value configurations and markets. Disruptive innovations ensure the creation of completely fresh markets and valuable networks. As a result, the various scientific views described in the literature review aim to note the definitions of innovation and the truly clear outcomes. So, multiple categories of innovations can be used for different institutions and their vast environment.

Many researchers have estimated the effect of ICT, digital economy and neural network technologies on economic growth over the past decade. Because ICT has a significant role in economic development, many researchers and scientists have concentrated on studying the effect of ICTs on economic growth at the regional and national levels. For example, Oliner and Sichel (2000) used ICT components, such as software, computer equipment, and digital equipment, such as input, and empirically tested for an extremely high

share of ICT in economic growth in the late 1990s. Kurniawati (2022) claims that appropriate ICT infrastructure policy supports feasible ICT penetration, and it drives the processes of economic development and innovation that contribute to economic growth. Other experts have shown that the attachment of economic growth to ICT is due to the replacement of computers, related equipment, and services, and not technological changes (Jorgenson, Stiroh, 2000).

While several empirical studies have confirmed that the spread of ICT plays a positive and significant role in improving economic growth, especially in developed countries (Röller, Waverman, 2001; Inklaar, O'Mahony, Timmer, 2005; Koutroumpis, 2009; Fernández-Portillo, Almodóvar-González, Hernández-Mogollón, 2020), other studies have shown that the spread of ICT adversely affects economic growth in many regions and countries of the world (Dewan, Kraemer, 2000; Pohjola, 2002; Bahrini, Qaffas, 2019).

It should be highlighted that there are studies that have examined the relations between investment and economic growth in telecommunications infrastructure, such as landline telephones and mobile phones in developed regions (Lee, Levendis, Gutierrez, 2012). On the other hand, they noted that in developing countries, such as the CIS countries, ICT have a significant impact on economic growth.

Several scientific studies examined the mechanisms of statistical research of ICT and digital technologies, including IT clusters (Popov, Semyachkov, Simonova, 2016; Kireyeva, Mussabalina, Tolysbaev, 2018). In addition to this, researchers also identified the ICT factor as an essential element of economic production. Palvia, Baqir and Nemati (2018) assessed the effect of ICT on social and economic development at different levels. Nevertheless, it has not been thoroughly studied from of the perspective of the final stakeholder, i. e., populations that are end-users of technology.

Roztocki and Weistroffer (2008) concluded that a broad framework linking economic development and ICT is important. In addition, the structure shows ICT, such as computing resources, the Internet, mobile telephony, GPS, and Wi-Fi, which allows researchers to analyse the degree of Internet use (the share of Internet users), estimate the cost of ICT production, etc. Further, Yurieva (2012) analysed the classification of regional economic entities in the following areas:

1) Analysis of the degree of communication, including the degree of integration and adaptability of communication.

2) Analysis of the degree of openness of the communicative process.

3) Analysis of the degree of communicative desire and management expectations.

According to the theoretical review, it becomes evident that the focus should give important topics that relate to rates of the benefit of the digital transformation in the spatial context. Currently, there are no exact and clear answers to these questions. Moreover, their design requires holistic scientific research with a deep analytical review. This will allow organising the process and study in detail the actual situation in Kazakhstan.

At present, ICTs are the engine of accelerated growth in many areas of the economy. Regional economic development, considering the effect of ICT, depends on two main pathways.

First is the production of ICT products and digital services. This is one of the economy's innovative and dynamically developing sectors, which significantly contributes to the development of innovations in the region and the country.

Second is the consumption and implementation of ICT in different economic and social sectors. This pathway is a particularly important cause that promotes digital competencies, for example, improving digital literacy, reducing routine operations, speeding up productivity, improving the population's quality of life, improving the quality of service, etc.

3. Research Methods

Many studies have attempted to quantify the geographical concentration of regions by industry (Bertinelli, Decrop, 2005; Feser, Renski, Koo, 2009; Aiginger, Rossi-Hansberg, 2006), including Russian scientists (Rastvortseva, 2013; Piskun, Khokhlov, 2019). The Network Readiness Index was used to assess digital readiness (Silva et al., 2022). The Herfindahl-Hirschman index and the Krugman localisation index were used to assess the concentration of regions by manufacturing subsector (Mirolyubova, 2013). However, they were not considered for IT industries. Some works analysed the potential of digitalisation of the region based on the example of the Central Federal District in Russia, using fuzzy-set methods (Tolstykh et al., 2018).

Among Kazakh scientists, there were also attempts to assess the digitalisation of the country's economy based on the WEF data "The Global Information Technology Report" (Berdykulova et al., 2014) or an organisational level (Alzhanova et al., 2020). However, this assessment was carried out at the country level and was static. A distinctive feature of the authors' methodological tools is

the assessment of the potential of the economy of Kazakhstan in the spatial context, considering the dynamic analysis of statistical data. Thus, the study was conducted based on a systematic approach using index and economic-statistical methods. The methodological base was ICT Development Index (IDI), Krugman Localisation Index (KLI), and Herfindahl — Hirschman Index (HHI) (Krugman, 1991; Hirschman, 1964). These indices were combined to assess the digitalisation potential of the regions in the case of Kazakhstan. The work used secondary data gathered from multiple sources at various time points from 2010 to 2020; wherever possible, there is data up to 2018. It included the examination of content in Russian, English, and Kazakh languages from the official websites of the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan and the International Telecommunication Union. For processing statistical data, Microsoft Excel was used. We also critically assessed and synthesised findings from academic articles, media publications, and country officials' statements.

When analysing the prerequisites and prospects for digitalisation of the regional economies, we proceeded from the statement that the main structure of the assessment indicators for the national and regional monitoring remains common, which in practice allows us to revise reasonably the strategic guidelines of the region for the implementation of innovations and to obtain an economic effect.

Certain aspects of the methodology of the combined ICT development index were used to assess intra-regional differences in Kazakhstan. So, the proposed methodological tools (determining the extent and level of ICT development) are performed according to an algorithm consisting of four steps:

The first step is the analysis of the degree of Internet use (the share of Internet users).

The second step is the analysis of the degree of costs for the production of ICT.

The third step is the analysis of the degree of digital literacy of the population (i. e., readiness of the population for the widespread use of ICT).

The fourth step is the analysis of the degree of regional specialisation in the field of ICT (identifying promising regions in the field of ICT).

Thus, the algorithm proposed by the authors has a four-stage gradation, which should be understood as a set of assessment indicators that contribute to and determine the prerequisites for digitalising the territories of Kazakhstan. This four steps research algorithm is based on developed countries' toolkit of assessing the country's readiness for digital transformation and its ICT development adapted for Kazakhstan in accordance with the available statistical information, especially in the context of regions.

As methodological tools for assessing industry localisation and specialisation, we suggest using the following complementary indices.

1) Krugman Localisation Index (KLI) is an absolute indicator for assessing industry localisation in regions (can be used for international comparisons). For calculations, we will use the modified Krugman index, which reflects the level of concentration of the ICT industry in this region according to the formula below:

$$IJ_{KLI} = V_{ITJ} / V_{IT}, \quad (1)$$

where: J — the country of regions; V_{ITJ} — gross value added to ICT industry in the region; V_{IT} — gross value added to ICT industry in the country.

2) Herfindal — Hirschman Index (HHI) is a relative value of the industry specialisation in the region, indicating the impact of the agglomeration effect. For calculations, we will use the aggregated Herfindahl — Hirschman index (IHHI), which reflects the degree of regional specialisation of the ICT industry according to the formulas (2) and (3) below:

$$IJ_{HHI} = (V_{IT} / V_{GRP}\ 100\ \%)^2 \quad (2)$$

where: J — the country of regions; V_{IT} — gross value added to ICT industry in the region; V_{GRP} — gross value added of the region; IJ_{HHI} — HHI index for the J-th region in the ICT industry.

The proposed indicators — modified Krugman localisation index and aggregated Herfindahl-Hirschman index — are distinguished by their accessibility, simplicity of evaluation, and ability to measure various indexes in the territorial context. Nevertheless, HHI indicator demonstrates the impact of the force of the agglomeration effect, as well as shows agglomerations that can become "growth poles" of the knowledge-based economy of Kazakhstan in the future. To summarise, the proposed methodological tools for assessing the industry localisation and specialisation of the region will allow a more objective and realistic characterisation of the degree of growth of areas in the ICT industry.

4. Analysis and Results

4.1 Analysis of the Level of Internet Use in the Territories of Kazakhstan

Extensive application of the capabilities of digital and computer networks, as well as the creation of a global ICT infrastructure can give users

Table 1

The percentage of Internet users in Kazakhstan from 2010 to 2020

Region	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Akmola	29.0	50.8	76.4	75.4	76.0	62.4	72.1	72.4	74.5	80.0	85.6
Aktobe	39.2	59.3	81.3	79.8	80.1	69.5	81.2	83.7	83.8	88.2	89.4
Almaty	26.4	48.7	57.8	56.0	57.3	87.3	88.2	88.9	88.2	89.8	89.2
Atyrau	28.0	66.0	85.0	82.8	82.9	71.6	74.2	75.0	80.4	83.3	78.6
West-Kazakhstan	35.2	59.4	72.2	70.8	71.0	93.9	69.4	75.6	78.8	81.3	84.2
Zhambyl	23.8	28.2	59.4	57.6	57.8	67.6	71.4	73.2	82.0	84.9	86.2
Karaganda	35.9	53.6	68.4	68.1	68.4	72.4	74.1	74.3	74.6	84.3	93.5
Kostanay	26.9	45.2	81.9	80.4	80.5	78.0	87.1	87.8	88.0	88.6	87.2
Kyzylorda	21.6	32.7	72.1	76.6	76.7	77.7	80.7	79.4	81.8	81.9	82.7
Mangistau	37.4	51.6	61.9	77.7	77.9	71.4	74.8	75.0	82.5	86.0	86.5
Turkestan	23.0	43.5	54.8	51.8	52.5	86.1	85.4	84.9	84.4	86.6	94.6
Pavlodar	30.3	58.0	68.3	70.5	70.8	70.2	76.9	77.1	78.8	82.3	88.6
North Kazakhstan	36.0	49.1	74.8	73.1	73.3	82.0	79.7	81.0	85.3	91.7	94.6
East Kazakhstan	31.4	43.4	71.7	71.0	71.4	70.4	77.2	78.7	80.9	82.6	83.3
Nur-Sultan c.	41.0	52.2	68.5	68.1	68.9	86.9	89.2	90.1	90.1	92.3	95.3
Almaty c.	49.0	63.3	71.6	73.1	73.6	80.9	86.2	87.1	87.7	89.5	92.9

a wide range of opportunities. In turn, it leads to strengthening the effectiveness of management in all areas of economic activity. In the last years, the growth of ICT and distribution of new types of services over networks led to the creation of new market practices in Kazakhstan.

Further, we propose considering the indicators of Internet access in the regional context, including broadband and mobile Internet (Table 1).

It should be highlighted that the data show the proportion of Internet users aged 16–74 years by regions of Kazakhstan. Most of the territories of Kazakhstan have a high level of ICT use in organisations and households. This suggests that Kazakhstan places significant emphasis on the growth of ICT sector. Additionally, the level of Internet users has grown significantly in many regions of Kazakhstan during the period from 2010 to 2020. Thus, in 2020, high level of ICT use was typical for the following regions of Kazakhstan: Nur-Sultan city (95.3 %), North-Kazakhstan (94.6 %), Almaty city (92.9 %), Kostanay region (87.2 %) and Aktobe (89.4 %). This clearly shows that the degree of digitalisation in these regions is much higher than in others. In turn, a low level of use was recorded in three regions of Kazakhstan: Akmola (85.6 %), West-Kazakhstan (84.2 %), and Kostanay (87.2 %).

Based on the percentage of the number of Internet users, it was revealed that many regions of Kazakhstan are characterised by growth trends. At the same time, the ICT market of Kazakhstan showed the following trends:

1) The number of users of Internet services for data transfer through programmes that provide communication services (for example, Viber, WhatsApp, Telegram, Skype, etc.) is increasing.

2) The volume of local telephone services and long-distance and international communications has been reduced.

The reason for these changes is the distributed use of the Internet. The country's population is increasingly using the Internet as a connection tool due to its low cost compared to mobile and fixed communications. In the meantime, the growth rate of Internet services does not coincide with the growth rate of Internet traffic in Kazakhstan. According to estimates, internet traffic in Kazakhstan is growing annually by 200 %. The reason for this discrepancy is that mobile operators annually reduce tariffs for Internet access services. In this regard, given the high growth rate of Internet traffic, operators are encouraged to focus on increasing the number of IT services, as this type of service has good potential in our country.

The portal of the electronic government of Kazakhstan — Egov.kz — deserves special attention. This digital resource is a progressive information structure designed to facilitate the interaction of state power with the country's population in many territories of Kazakhstan. E-government is based on a distributed ICT infrastructure deployed nationwide. Egov.kz is part of the administrative reform, digital transformation set by the principles of the digital economy.

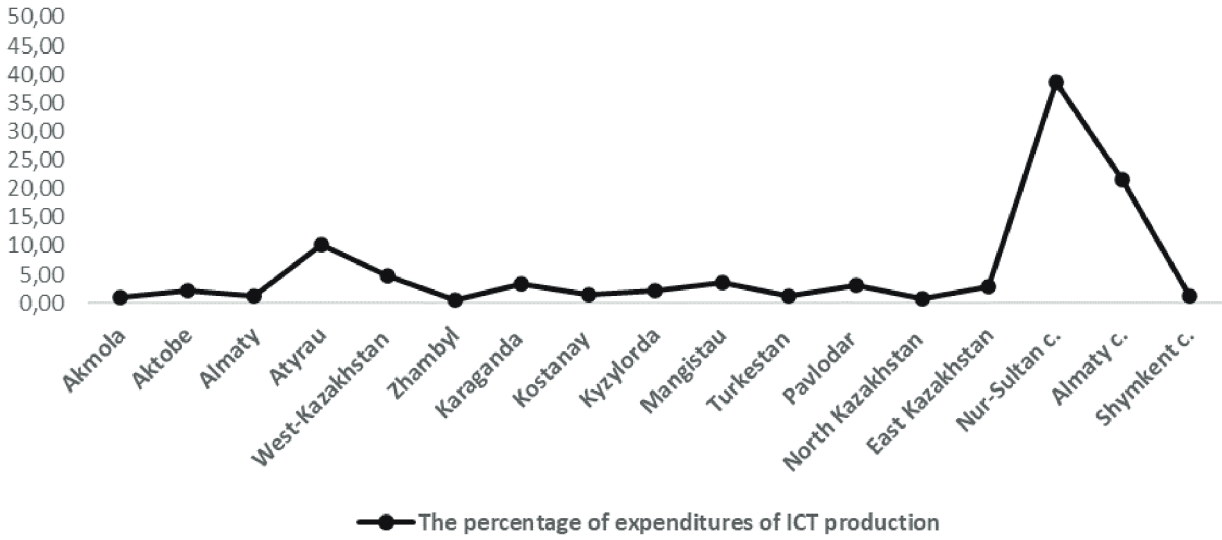

Fig. 1. *The percentage of expenditures on ICT production in Kazakhstan for 2020*

4.2. Estimation of ICT Production Cost

The main value of the analysis of ICT effectiveness is the degree of costs to produce ICT. Expenditures on ICT show the actual costs expressed in cash for developing, acquiring, implementing and using ICT.

In our scientific study, ICT expenditures are grouped as follows:

— acquisition of software (purchase of ready-made software of all types, operating systems, translators and compilers, software design and development tools, and other auxiliary tools necessary for developing software on their own);

— independent software development within the organisation;

— training of human resources related to the use and implementation of ICT (payment for training services for specialists and employees of the organisation, if retraining is not included in the sheet of their job responsibilities and is paid separately);

— payment for the services of third-party organisations and specialists related to ICT (payment for ICT services provided by a third-party organisation that performed work under civil law contracts, except for the cost of communication services and staff training).

Table 2 presents the costs of ICT production from 2010 to 2020.

According to the data for 2010–2020, the level of costs to produce ICT has grown 2.6 times. Thus, in 2010, the level of costs to produce ICT was estimated at 147.54 billion KZT. In turn, in 2020, the level of costs amounted to 388.93 billion KZT. In addition, most of the cost goes to the acquisition of software and a third-party organisation's payment for services.

Hereinafter, the goal of the research is to assess the costs of the different regions of Kazakhstan on ICT in order to identify promising areas that have regional competitive advantages. The information base of the study was composed of data for the regions of Kazakhstan by 2020 (Fig. 1).

The data demonstrate that, in the regional context, ICT costs are presented rather randomly. The largest and most significant increase in ICT production costs in 2020 was observed in two regions of Kazakhstan: Nur-Sultan city (38.60 %) and Almaty city (21.58 %). In monetary terms, 84.4 billion KZT was spent in Almaty city and 150.1 billion KZT in Nur-Sultan city. Moreover, territories with the lowest degree of ICT production costs are highlighted: Akmola (0.95 %), North-Kazakhstan (0.82 %), Zhambyl (0.6 %). This is causing the low

Table 2

Expenditures of ICT production in Kazakhstan from 2010 to 2020, in billion KZT

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Software acquisition	27.3	23.7	34.5	21.3	32.9	69.2	37.1	75.0	52.3	55.7	64.7
Independent software development within the organisation	2.18	2.0	3.8	5.5	3.3	8.7	11.6	10.9	5.2	13.1	17.3
Staff training	1.4	1.4	2.2	3.4	1.8	1. 4	1.3	11.8	2.1	8.1	1.4
Payment for third-party ICT related services	15.6	25.0	51.7	35.3	46.5	36.6	78.6	105.1	107.5	121.7	165.3

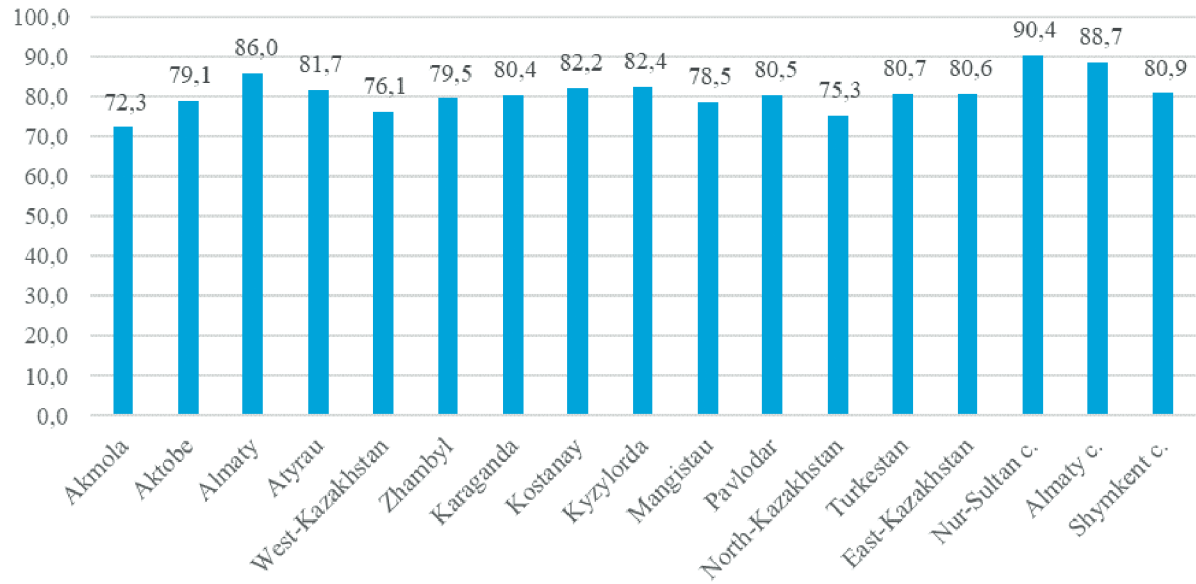

Fig. 2. *The percentage of the population in Kazakhstan with the skills to use a personal computer, smartphone, tablet, laptop in 2020*

level of economic growth in these regions and the insufficient level of development of ICT infrastructure. The indicators of Zhambyl and North-Kazakhstan regions are especially low, where the cost of ICT production amounted to 2.3 billion KZT and 3.2 billion KZT, respectively.

An analytical review of the actual situation in the field of ICT production costs shows that the role of digital and communication technologies is growing in Kazakhstan. Total cost of ICT in 2020 increased twice in comparison with 2010. It can be stated that the ICT industry is developing rapidly in Kazakhstan. Moreover, it should be noted that the tendencies of growth of the ICT sector are unbalanced in the regional context. Indeed, a great deal of ICT expenditure accounts for ICT account for two cities of republican significance, namely, Nur-Sultan city and Almaty city. Regions of this type are distinguished by a high degree of infrastructure components of ICT. Therefore, these cities have regional competitive advantages in the field of ICT development.

4.3 Assessment of digital literacy in Kazakhstan

Today, the digital economy opens enormous opportunities that provide the transition to a new technological and industrial structure of Industry 4.0, while exacerbating the problems of digital inequality between different segments of the population. In this regard, many Kaznet users are at risk and need to be educated in the proper use of ICT. Moreover, one of the essential tasks of national security becomes the problem of universal digital literacy of the population of Kazakhstan.

The degree of digital literacy is assessed in order to investigate the degree of digital knowledge and the willingness of the population of Kazakhstan to use ICT. In addition, an analysis of the degree of digital literacy will allow us to fix the imbalances in the development of the digitalisation of Kazakhstan regions' economy. Moreover, the study will provide not only an average analysis of the degree of digital knowledge, but also reveal the development index of each region, thereby allowing us to compare these parameters and find the most attractive regions in the field of ICT.

Insufficient penetration of wired telephony and the lag in providing families with home computers have become the leading causes for the delay in the growth of ICT in the western territories of Kazakhstan. As a result, cheap mass technology is inaccessible for a significant number of Kazakhstan's households.

In general, a basic set of knowledge and skills of the population of Kazakhstan was evaluated here in the following categories:

1) solution of the problems encountered in protecting the computer and personal data;

2) the use of software and hardware solutions in professional activities;

3) the use of various digital devices (digital cameras, digital video cameras, webcams, digital television, DVD players, projectors).

Figure 2 shows the proportion of the population of various Kazakhstan's regions with the skills to use a personal computer, smartphone, tablet, laptop via the Internet.

According to the presented data, almost all regions of Kazakhstan demonstrate high rates of having the skills to use a personal computer, smartphone, tablet, and laptop via the Internet. Thus, the following regions of Kazakhstan demon-

strate their skills to a greater extent: Nur-Sultan city (90.4 %), Almaty city (88.7 %) and Almaty region (86.0 %). At the same time, average indicators were recorded in Kyzylorda (82.4 %), Kostanay (82.2 %), and Atyrau (81.7 %), respectively. In general, a basic set of knowledge and skills of the population of Kazakhstan is evaluated here in the following categories:

1) using a personal computer, smartphone, tablet, laptop;

2) using standard programmes (text and table editors and so on);

3) receiving services through the Internet.

Based on the analytical review, Kazakhstan is adapting to new conditions for the functioning of the ICT sector. In this connection, the development of the ICT market has outlined the following trends.

Firstly, most of the territories of Kazakhstan have a high level of ICT use in organisations and households. The data from 2010 to 2020 show that the level of Internet users has grown significantly in many regions of Kazakhstan. According to the data presented, the leader was clearly defined — this is Nur-Sultan city (95.3 %). This is not surprising since the network of data processing centres in the interests of government agencies and large corporations is actively expanding in the metropolitan region, which has a positive effect on the ICT market. However, based on the Internet access indicators during the tenth period from 2010 to 2020, it is quite obvious that Kazakhstan is pursuing an active policy to increase the digital literacy of the population and the degree of digital flows.

Secondly, in the regional context, ICT costs are presented rather randomly. An analytical review of the actual situation in the field of ICT production expenditures shows that the role of digital and communication technologies is growing in Kazakhstan. It can be reasoned that the ICT industry in Kazakhstan is rapidly developing. Moreover, it should be highlighted that there are unbalanced development trends in the ICT sector in the regional context. Therefore, most of the expenditures of ICT are in 2 cities of republican significance (Nur-Sultan city and Almaty city). Regions of this type have shown a high level of infrastructure and all components of ICT. Therefore, these cities have regional competitive advantages in the field of ICT development.

Thirdly, the regions of Kazakhstan demonstrate high rates of having the skills to use a personal computer, smartphone, tablet, and laptop via the Internet. Thus, in 2020 the following regions of Kazakhstan demonstrate their skills to a greater extent: Nur-Sultan city (90.4 %), Almaty city (88.7 %), and Almaty region (86,0 %).

Fourthly, there are backward regions, i. e., regions with low potential for developing the infrastructure. In particular, these are regions of Kazakhstan with low ICT indicators.

It is possible that the rapid transformation of the economy, which creates new opportunities for engaging in various digital and ICT, is beneficial for Kazakhstan's households who are able to use these opportunities. The main reasons for the lag in some regions of Kazakhstan in the development of ICT were the relative lag in providing families with home computers, the lack of penetration of landline telephony, and, as a result, the inaccessibility of cheap mass technology for a significant number of Kazakhstan's households. Nevertheless, there are significant imbalances in the accessibility of services for inhabitants of diverse country regions. An increase in Internet penetration may contribute to the intensive development of E-commerce and digital content.

Nevertheless, this is merely a hypothesis at this step. Further, the study is required to throw light on these issues. The final part of this research has concerned with explaining the observed level of the ICT localisation and the strength of the agglomeration effect.

4.4 Analysis of the Degree of ICT Industry Localisation in Kazakhstan

We propose to analyse the degree of localisation of the regions of Kazakhstan in the ICT sphere according to the methodology proposed above. Krugman localisation index (KLI) can show positive and negative estimation results in development dynamics. However, negative values in the dynamics of development are explained by unequal weight in various parts of the distribution: the greater the value of the regional localisation index, the higher the concentration of industry in the region.

Next, we intend to evaluate the localisation of the industry. Thus, we have identified attractive regions for the ICT industry by using the converted Krugman localisation index (KLI). All the indices used to evaluate the industry localisation have absolute units. Collected data for the estimation have been taken from the statistical information of the Committee on Statistics of the Republic of Kazakhstan.

Further, the indicators of specialisation of the ICT industry for all other regions of Kazakhstan were calculated. The estimation results are summarised in Table 3.

Table 3

Estimated indicators for the ICT industry in Kazakhstan by 2010 and 2019

Region of Kazakhstan	Estimated indicators (KLI)		Estimated indicators (HHI)	
	2010, in parts	2019, in parts	2010, in parts	2019, in parts
Atyrau	—	—	—	—
Aktobe	0.1978	0.2311	0.0771	0.0176
Akmola	0.0031	0.0028	0.0001	0.0012
Almaty region	0.0102	0.0115	0.0003	0.0002
East-Kazakhstan	0.0021	0.0045	0.0004	0.0013
West-Kazakhstan	0.0402	0.0513	0.0012	0.0156
Zhambyl	0.0014	0.0012	0.0002	0.0019
Karaganda	—	0.0338	—	0.0144
Kostanay	—	—	—	—
Kyzylorda	—	—	—	—
Mangistau	—	0.0091	—	0.0006
Pavlodar	—	0.0014	—	0.0003
North-Kazakhstan	0.0212	0.0119	0.0053	0.0271
Turkestan	0.0052	0.0063	0.0001	0.0033
Almaty city	0.6832	0.5847	0.0825	0.0756
Nur-Sultan city	0.0391	0.4564	0.0013	0.0633

Analysis of the regional specialisation of Kazakhstan allowed us to conclude the following.

First, according to calculations in the field of ICT, the most specialised region is Almaty city (about 70 % of the total ICT output). In general, the conclusions obtained are logical because there are many ICT companies in Almaty (Logycom, Asia-Soft, Ak-Cent Microsystems, Favor-IT, Real-Soft, etc.). This region has good indicators of digital literacy and ICT use by the population, investment potential, and a high level of human resources. Almaty city is a place for competitive, export-oriented, and technological production of goods (including services) in the field of ICT. Moreover, the products of Almaty developers are in demand not only in Kazakhstan but also in many CIS countries and some European countries. It should be emphasised that, in 2019, the estimates of Almaty city were lower than those in 2010, according to estimated results (KLI and HHI). The declining trend in growth rate is associated with reducing the cost of ICT projects, the reduction in investment and a decrease in demand.

Second, according to the results, the three average specialised regions of Kazakhstan are identified: Nur-Sultan city, Aktobe and Karaganda. In these regions, work has intensified, individual ICT development plans are established, and problems and pathways to solve them are discussed. In general, the planned support includes assistance in attracting direct investment, ensuring participation in international exhibitions, providing support measures within the Astana Hub, promoting data centres, developing 5G and more.

Third, there is a group of outsider regions, i. e., regions with a significant lag in developing ICT infrastructure. It turned out that not all areas of Kazakhstan have a sufficient level of ICT development. Based on Kazakhstan's statistical data for 2010–2019, we can talk about the presence of different types of territories according to the degree of availability of digital technologies, starting from the accessibility of the volume of products produced to the complete absence. In certain regions, there is no productivity in the field of ICT, such as Atyrau, Kostanay and Kyzylorda. These regions still do not have the necessary ICT development level, which limits the ability of the population to find work, improve their economic condition, access digital services, establish social ties, get education, etc.

Looking at the above and the analysis conducted, the level of ICT growth in different regions of Kazakhstan is significantly differentiated and has various indicators. That is why for Kazakhstan, like any other country, it is important to overcome the problem of digital inequality and ensure the development of ICT in large cities and backward regions. Solving this scientific problem will allow us to determine the readiness of any region for digitalisation, identify leading regions and disseminate their experience, as well as manage the development of digital infrastructure of various types of territories, tracking the dynamics of the process over time. On the one hand, the need to determine the level of digitalisation of any territorial entity is the necessary condition for the project's development. On the other hand, there is a need to decrease digital disparity and create

communication among the population in the various regions of the country. In general, Almaty city, Nur-Sultan city, Karaganda, and Aktobe are attractive regions for the growth of ICT. Such areas will be favourable "growth poles", oriented to transfer high technology and knowledge to the vast periphery of the country.

5. Conclusions

According to the literature review, it becomes clear that attention should be paid to the analysis of the digitalisation of various territorial entities. This will allow researchers to identify the leading regions, disseminate their experience and implement the process of managing the development of digital infrastructure of various types of territories, tracking its dynamics over time. Currently, there are no unambiguous answers to these questions. It is necessary to analyse the degree of digitalisation of various types of territories in Kazakhstan in order to fully present and systematise the ongoing processes for the CIS countries and other developed countries that are ready for complete digitalisation. Based on the analytical review done, it is clear that Kazakhstan is adjusting to the ICT sector's new operating conditions. Therefore, following development trends in the ICT- market are expected.

First, most of the territories of Kazakhstan have a high level of ICT use in organisations and households. During the period from 2010 to 2020, the level of Internet users in many regions of Kazakhstan has grown. According to the data presented, the leader was clearly defined — this is Nur-Sultan city (94.6 %). This is not surprising since the network of data processing centres in the interests of government agencies and large corporations is actively expanding in the metropolitan region, positively affecting the ICT market. The internet testifies to the growing role of ICT in the regions of Kazakhstan. There has been a sharp increase in Internet users in 2010 and 2020, respectively, 31.6 % and 89.0 %. This is obvious since Kazakhstan is pursuing an active policy to increase the digital literacy of the population and the level of information flow.

Second, in the regional context, ICT costs are presented rather randomly. A review of the current situation in the field of ICT production costs shows that the role of digital and communication technologies is growing in Kazakhstan. It can argued that the ICT industry is developing rapidly in Kazakhstan. Moreover, it should be emphasised that the development trends of the ICT sector become unstable in the regional context. Thus, most ICT expenditures are accounted for two cities of republican significance, namely, Nur-Sultan city and Almaty city. A high level of infrastructure and all components of ICT characterise regions of this type. Therefore, these cities have regional competitive advantages in the field of ICT development.

Third, the regions of Kazakhstan demonstrate high rates of having the skills to use a personal computer, smartphone, tablet, and laptop via the Internet. Thus, the following regions of Kazakhstan demonstrate their skills to a greater extent: Nur-Sultan city (90.4 %), Almaty city (88.7 %) and Almaty region (86.0 %).

Fourth, there is a group of outsider regions, i. e., regions with a significant lag in developing IT infrastructure. In many areas, there is no productivity in the field of ICT, such as Atyrau, Kostanay, and Kyzylorda. These regions still do not have the necessary ICT development level, which limits the ability of the population to find work, improve their economic condition, access digital services, establish social ties, get education, etc.

In this fashion, after evaluating the digitalisation potential of the Kazakhstani regions, we conclude that the regions of Kazakhstan have varying levels of ICT development, which is why they have different prerequisites and prospects for digitalising their economy. Accordingly, Almaty city, Nur-Sultan city, Karaganda, and Aktobe regions have high digitalisation potential. Among those regions with a high digitalisation potential of the economy, Pavlodar and Kyzylorda regions can be mentioned, whereas Zhambul, Akmola, Karaganda North-Kazakhstan, West-Kazakhstan, Mangistau and Atyrau have the lowest digitalisation potential. The underdevelopment of ICT causes such a lag in opportunities of these regions. Insufficient provision of the households with personal computers and low penetration of wired telephony make the cheap mass technology less accessible for a notable amount of Kazakhstan's citizens. Moreover, an observable imbalance in the accessibility of various ICT services and the growth in the Internet penetration levels in those regions will contribute to the extension of E-commerce activities.

The above information and the conducted analysis present refutations and evidence of the hypothesis proposed earlier. We proceeded from the scientific suggestion that digitalisation processes are beginning to develop in Kazakhstan, and that there are specific sources for the development of ICT. Thus, we can argue the benefits and drawbacks of the following suggestion. The weak diversity of the region's economy and the backwardness of ICT infrastructure were negative fac-

tors in developing the ICT market. On the other hand, the positive factor is the presence of various programmes for the ICT development. Kazakhstan is actively working to raise the development degree of the public digitalisation and ICT market. It should be emphasised that our hypothesis proved to be accurate, as evidenced by the analysis and results obtained.

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