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Digital Divide of Resource-Based (Oil and Gas) and Service-Dominated Regions

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Abstract: The following paper explores the development of a statistically based index evaluating digitalization processes to assess the digital divide between the regions of Kazakhstan: resource-based (oil and gas) regions and regions where the service sector dominates the GRP. As a method for forming such an indicator, the authors suggest using factor analysis, which reduces the dimension of factors while maintaining the reasoning behind a significant part of the data variability. This approach is preferable because the index is formed on the basis of statistically objective estimates rather than that of subjective expert opinion. The results of the factor analysis were interpreted as the following two qualitatively different subindices that formed the final Economy and Society Digitalization Index, namely, for resource-based (oil and gas) regions: subindex of digital consumption by households and subindex of digital consumption by organizations; for service-dominated regions: subindex of digital consumption by households and organizations, and subindex of digitalization of labor management processes. The combined values of the calculated subindices allowed us to conclude that the introduction of information and communication technologies into the consumer environment is greater than into the activities of economic entities. Open innovations are revealed to create additional opportunities for obtaining new knowledge and additional tools and ideas that can lead to bridging the digital divide in the regions of Kazakhstan. The analysis of descriptive statistics of these values allowed us to draw a number of conclusions available that can be used to form regional digital policy. First, the regional population shows a fairly homogeneous high level of consumption of telecommunications services, which indicates their availability. Second, the majority of economic entities throughout the country have successfully passed the first stage of digitalization, which consists in the use of Internet technologies; although, not all of them are characterized by a trend toward the digitalization of business processes. Thirdly, for most organizations, the digital development of human capital still remains an important task. Further statistical research of regional differentiation of the values of the proposed digital development indicator will allow a deeper understanding of the reasons for the digital divide in Kazakhstan.

Keywords: digital divide; digitalization; digital economy; factor analysis; digitalization index; resources-based (oil and gas) regions; service-dominated regions; regional differentiation; open resources; open innovation; open innovation dynamics

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1. Introduction

The active introduction of Industry 4.0 technologies in Kazakhstan serves as the basis for the domestic economy's reorientation toward an innovative development path. The digital space forming in the country is affected by the socio-economic space characterized by a high degree of heterogeneity. Due to this circumstance, the issue of digital inequality of territories is acute for Kazakhstan and requires scientific study and practical overcoming. Digital inequality (also known as the digital divide) is considered an important criterion for dividing people into rich and poor; it emerges due to the uneven economic development of individual territories. The digital divide manifests itself in different opportunities for providing access to rapidly developing information and communication technologies (ICTs) that play an important role in various economic sectors.

In the last decade, the organization of scientific and innovative activities and the nature of communication in them have undergone profound changes transforming the entire system. Open innovations are becoming more and more relevant in the process of disseminating information and knowledge, overcoming digital inequality in the regions. The traditional model of business processes assumes a bet on internal human capital, whereas the concept of open innovation aims at the openness of innovation activities from different area experts. In this context, the adaptation of both individuals and entities to the culture of open innovation and open business models is of utmost importance.

The problem of digital inequality has been researchers' focus of attention for over twenty years and it remains relevant. Concurrently, a literature review shows a shortage of scientific research in Kazakhstan not only in the field of studying all levels of digital inequality, but also papers on interregional differences at the level of digitalization. This is especially true for the country's oil and gas regions where raw material specialization predetermines regional imbalances at the level of economic development. Gaps in the research of interregional digital inequality in Kazakhstan are explained by the insufficient information base and the lack of a developed and scientifically based Economy and Society Digitalization Index.

To date, both individual scientists and research institutes have repeatedly presented various options for calculating integral digital economy development indicators alike. We, however, believe the methodology for preparing such an index requires additional research that needs a statistically reliable selection of factors for calculation, as well as an up-to-date list of indicators. As the most suitable method for solving this problem, we used factor analysis, the essence of which is to represent the object of research in the form of several components based on a larger number of factors. On the one hand, factor analysis allows coverage of all aspects of the digitalization process and the most compact description of the object of research on the other.

Implementation of this method in practice had us use a set of indicators reflecting the degree of penetration and use of telecommunications services in regional markets between 2016 and 2021. These indicators include all available data on the geographical availability of services, and the use of telecommunications services by households and organizations.

The large number of regions in Kazakhstan with different levels of economic potential challenges us to investigate regional imbalances of digital difference, namely, to seek tools for the most complete and objective assessment and overcome this inequality. Such an assessment is valuable for developing an effective state policy to equalize the regions of Kazakhstan, and to improve the quality of life and the position of the regions in both business and social ratings. The research also develops an empirical basis for further research on digital inequality issues for countries and regions worldwide where the extractive industry predominates in the structure of the economy and those lagging behind in the implementation of Industry 4.0.

As the object of the study, we selected the regions of Kazakhstan grouped into two clusters:

- Resource-based (oil and gas) regions;
- Service-dominated regions.

The aim of the study is to develop a statistically sound index that evaluates processes of digitalization and the digital gap between resource-based (oil and gas) regions and regions where the service sector dominates the GRP.

The main research tasks include:

- Identification of the main causes and conditions for regional digital inequality in Kazakhstan;
- Analysis of factors affecting the process of regional digitalization in Kazakhstan;
- Building an Economy and Society Digitalization Index in the regions of Kazakhstan;
- Search for tools to overcome digital inequality in the studied regions of Kazakhstan.

2. Literature Review

In recent years, the concept of a regional digital divide has become increasingly common in the scientific economic literature [1–5]. This is a phenomenon of a post-industrial society and the fifth technological order expressed as the significant difference in the level of availability and use of modern information and communication technologies depending on gender, age, and region of residence. The existence of such digital differentiation entails qualitatively varied living standards, thus making research of this category at the regional level especially relevant.

If, initially, digital inequality was perceived as an issue of spatial unevenness in the distribution of digital technologies between countries and regions [6–8], then over time, the research interest shifted from a technological component toward the study of ICTs from the standpoint of a social approach. Accordingly, digital inequality, being a multidimensional phenomenon, has become the subject of interdisciplinary research from the standpoint of sociology, economics, political science, and a number of other sciences [9]. Such a shift in emphasis has led to the emergence of numerous papers exploring the relationship between the availability and use of ICTs and age criteria [10–12], gender specificity [13,14], income and educational level [15,16], professional and other characteristics of users [17,18], and the level of entrepreneurial activity [19,20], which determines the different scales of ICT business development and various financial opportunities for the introduction of digital technologies.

The digital divide concept's theoretical basis originates in the works by Hargittai [21] and Gunkel [22] and is based on the theory of three-level digital inequality. According to the said theory, the development of the information society (digital divide) is assessed according to three components [23]:

(1) ICT readiness (availability of infrastructure, ICT accessibility),
(2) ICT intensity (degree of use of ICTs in society), and
(3) ICT impact (effectiveness of the use of ICTs).

The interrelation of these elements is unequivocal: there is no access without infrastructure, and the lack of access restricts the use of ICTs. In addition to access and use, reaching the endpoint in the form of ICT impact depends either on capabilities or skills. Skills have a decisive impact on socio-economic development and the development of digital technologies. The lack of appropriate skills will render the use of new technologies and potential opportunities impossible, thus negatively affecting the further development of this entire sector of the economy.

Van Deursen and Van Dijk [24] believe that currently, the theory of the three-level digital divide offers the most comprehensive description of the issue of digital inequality that considers Internet and ICT access (the first level) and social manifestations at subsequent levels (practical use and effects).

An attempt to analyze the state of the ICT sphere and the problems of digitalization of resource-based regions is the focus of attention of a multitude of modern scientists and specialists. To cite an example, Smagulova et al. [25] determine the serious wear of electrical equipment and agricultural machinery as barriers hindering the promotion of digital technologies in the energy and agro-industrial complexes of Kazakhstan.

Li et al. [26] note that the digital economy has a deterrent effect; with its development, the impact of coal power on carbon emissions is decreasing gradually. This effect has been deemed significant in non-resource regions and Eastern China and insignificant in resource-based provinces and in Western and Central China.

The raw material factor, interpreted in the scientific literature [27,28] as the "resource curse" of countries with transition economies and rich in mineral resources, has a dominant impact on socio-economic development. For instance, the raw material economy sees the hindrance of institutional transformation processes [29], because the presence of a raw material factor in the economy contributes to the opacity of the distribution of natural resource rent in society. An inefficient institutional environment hinders economic growth by reducing quality indicators, which, in turn, has a negative impact on the quality of life, reflected in an increase in the stratification of society, and an increase in digital inequality.

Let us consider the factors and variables used to assess the processes of digitalization and the regional digital divide.

To assess the regional digital divide at each step of the theory of three-level digital inequality, Gladkova et al. [9] propose using various indicators and variables:

- Status (number of network subscribers, number of households with Internet access, average cost of digital services, connection speed, type and number of devices for network access, etc.);
- Intensity of use (population's digital literacy/skills, goals (motives) of Internet usage considering sociodemographic factors, Internet usage practices, etc.);
- Assessment of the ICT impact (dynamics and specifics of the use of online services and services, e-government's functioning, indicators for assessing users' professional and personal self-realization, etc.), to name a few.

A number of studies conclude that information technology costs have a positive impact on the development of information and communication infrastructure both in the raw materials sector and at the regional level. In this connection, Litvinenko [30] explores the digital economy's impact on the technological development of the world mineral industry. He concludes that insufficient financing of the information infrastructure leads to a significant problem for the development of digital processes in the economy.

Lutoshkin et al. [31] note the positive role of information technology costs as well. The researcher concludes that investments in ICT are of a capital nature, which above all implies a return on investment in the long term. Since investments in ICT are usually long-term, the introduction of new information systems and the restructuring of enterprises and companies take quite a long time. Van Dijk [32], Elena-Bucea et al. [33], and Szeles [34] make conclusions about the importance of ICT costs for bridging digital gaps. They note that with the growth of sales via mobile technologies and the Internet, and the growth of the use of cloud technologies, a further increase in ICT costs on the part of the state and companies is quite expected.

Knowledge is an important resource of a dynamically developing digital economy. This actualizes the question of the need for the process of continuous development of human resources and professional development.

Giebel [35] explores the relationship between the digital divide and the knowledge economy using the example of the Republic of Korea and South Africa. The author concludes that the movement toward open innovation opens up new opportunities for obtaining knowledge and skills that contribute to reducing the digital divide. The very concept of "open innovation" is closely related to the peculiarities of the knowledge economy, which has been noted by numerous researchers [36,37]. At the present stage, most of them agree that it is not entirely correct to talk of digital inequality as inequality of a technological nature only. As researchers have repeatedly noted, simply having access to the Internet does not guarantee its use. There is a whole multitude of reasons for this, e.g., sociodemographic factors: correlations between age, gender, ethnicity, and income level of citizens, and the frequency of their use of ICT, their lack of motivation, the needs and/or knowledge and skills of the citizens to use Internet technologies, and many others. Currently, knowledge and information are actively disseminated via the Internet and other digital platforms and channels. This allows the business to attract new participants in the business process in a short time. This process takes place mainly through open innovations. All this means that the combined knowledge and information of one firm or other interested parties can lead to the appearance on the market of new products, processes, or ideas.

Digital inequality affects the opportunities and means of R&D and, therefore, the number of expected innovations. Bridging the digital divide opens up development and growth opportunities for less-developed countries. The possibility of innovation is one of the main factors for international competition in various markets. Several solutions are proposed to bridge the digital divide and the existing gap. One of these is open-source software, which has both advantages and disadvantages [38]. Since "the best" solution is still yet to be found, several countries, such as South Africa, have implemented programs to close the gap with the knowledge economy and turn the country into a knowledge society [39].

Giebel [35] suggests a number of solutions to bridge the digital divide:

- National strategies. National strategies supporting regional socio-economic equality play a special role in overcoming digital inequality [40]. These strategies are being implemented today under the influence of various factors, including: (a) macro-level ones, such as the state of technological and economic development of the region (level of broadband access spread and Internet penetration in households, specifics of regional political culture, state of the education system, etc.); and (b) micro-level ones, such as the openness of the regional media system.
- Open resources. Open resources are tools for overcoming regional digital inequality. They help people in developing countries to take part in research, and to use open data or knowledge via the Internet. The concept of open resources is known thanks to the Linux operating system. It has both disadvantages and advantages. The advantages are that the software is inexpensive or accessible and even free to run. Open resources provide an advantage for developing countries and regions of the world, as well as for individuals unable to afford expensive software licenses [41,42]. Open resources can bring about such positive effects as the formation of skills to deal with new software and the creation of new software products [43]. Furthermore, they allow working on research projects with software that can provide good end results [44].
- Open innovation. Modern dynamics of open innovation implies attracting external resources, experts, innovators, and technologies [45–47]. This model enables addressing the tasks of internal innovation faster and much more efficiently. Moreover, for companies that do not have their own innovation departments, open innovation model becomes the only solution to the problem of effective innovative developments. The advantages of open innovation include the following:
- The very process of innovation development becomes much more efficient and faster.
- An entire department of employees on a permanent basis becomes redundant, which leads to a reduction in innovation costs.
- The opportunity to receive an objective expert assessment from the outside.
- The ability to choose among numerous startups and projects.

Disadvantages of open innovation may include the following:

- Market openness consistently generates a number of risks associated with the leakage of information that gives competitive advantages in the market.
- High risks from the corporate cybersecurity point.
- Risks of making the wrong choice among startups and companies offering innovative products and technologies, and making financial investments doomed to failure.
- Risk of losing talented corporate innovation team members to competing companies.

We believe that open innovation is not the best solution for individuals who do not have access to information and communication technologies as they will struggle to participate in the processes of creating and disseminating new knowledge and innovations. Moreover, open innovations do not directly create opportunities to bridge the digital divide.

They rather create an opportunity to gain new knowledge, overcome the language barrier, and obtain additional means, ideas, and tools that can lead to bridging the digital divide.

Transitioning to the digital economy imposes more requirements on IT qualifications. A number of researchers [48–50] note that it is the personnel potential in the IT sector in the context of ever-increasing digitalization that can become the main source of growth of the overall national economy.

Cloud services are one of the key components of the emerging digitalization infrastructure [51–53]. Their widespread development has radically changed the structure of the global IT market. In the medium term, the role of cloud services will only increase. Cloud services are easily accessible from anywhere in the world, so their export potential is huge and their role in the development of the digital economy is great.

An important condition for the digitalization of the economy and business is the availability of an uninterrupted Internet connection. Today, computer networks are playing an increasingly important role in creating innovations and the transition to innovative development. The Internet is already the main source of information for society [54,55]. The use of information technologies and the Internet as a means of communication between entities such as public authorities, legal entities, and individuals leads to qualitative changes in almost all spheres of life, new opportunities for the development of all economic entities [56,57], increases labor productivity, and, as a result, efficiency and competitiveness of the economy. Companies transform, new forms of doing business emerge, and new services emerge.

It should be noted that scientists and experts in Kazakhstan have presented only a limited list of studies not only in the field of studying all levels of digital inequality, but also papers devoted to interregional differences in digitalization level. This is largely due to the insufficient data base for this line of work.

To date, both individual scientists and research institutes have repeatedly presented various options for calculating integral indicators of digital economy development. A number of international indices and ratings are devoted to the use of the index method in the study of inter-country and interregional differences in digital development.

Back in 2007, the International Telecommunication Union proposed the ICT Development Index. This index evaluates the development of ICT in countries worldwide by eleven indicators. The index combines these indicators into a single criterion designed to compare the achievements of the world's countries in the development of ICT, and it can be used as a tool for comparative analysis at the global, regional, and national levels. These indicators deal with access to ICTs, and their use and skills, i.e., practical knowledge of these technologies by the population of the countries covered by the research. The authors of the study emphasize the fact that today the level of ICT development is one of the most important indicators of the economic and social well-being of the state. Currently, the release of the index is suspended due to the revision of the indicators included in this research coupled with the methods of their measurement.

In turn, the European Union, the authors of the International Digital Economy and Society Index (I-DESI), evaluates the level of development of the digital economy in countries based on five main factors: the spread of broadband Internet and communication quality, Internet usage, human capital (how well residents handle network technologies), integration of digital systems and technologies, and the development of digital services and public services.

The World Economic Forum's Network Readiness Index measures the level of ICT development by three main groups of parameters: the availability of conditions for the development of ICT; the readiness of citizens, business circles, and government agencies to use ICT; and the level of ICT use in the public, commercial, and public sectors.

The correct choice of econometric tools has a great influence on the study of the processes of digitalization and digital inequality. Here, the authors highlight the problem of choosing and constructing a proxy variable responsible for assessing the state and development of ICT. Some researchers use indicators of a certain technology development for this purpose. Adhering to this strategy, they often choose indicators such as the number of IT specialists, the share of enterprises using computers and having Internet access, or the share of households with Internet access [58]. These parameters reflect the level of penetration of public information technologies in business activities. Some papers simultaneously present results on models with various variables, including the share of enterprises using cloud IT services.

An alternative option is to create a new variable out of several indicators using the dimensionality reduction method. Bagchi [59] defined global information inequality as the difference between a country's ICT Index and its value in the United States. To build the corresponding index, he used four information technologies: the availability of a fixed telephone connection, mobile phones, personal computers, and an Internet connection per thousand people. In contrast, Doong and Ho [60] chose only two of the four variables, the degree of penetration of mobile phones and Internet, and as the other two determinants, the authors used financial indicators, telecommunication revenues and investments. Vicente and Menéndez [61] selected ten variables related to ICT and, using factor analysis, they identified two main components: ICT infrastructure and distribution among businesses and households (factor 1) and e-government and the cost of Internet access (factor 2). Later Ayanso et al. [62] made an attempt at improving the methodology for calculating the ICT Development Index by implementing cluster analysis based on eleven indicators included in it.

When selecting explanatory variables to identify the determinants of digital inequality, Dasgupta et al. [63] explored the influence of four factors: per capita income, the share of urban population, the policy competitiveness index, and the vector of regional programs. Apart from income, Pohjola [64] includes the relative cost of ICT equipment, the share of agriculture in GDP, the openness of the economy, and human capital metrics, as determinants. Billon et al. [65], too, in addition to GDP per capita, delve into the contribution of the following variables to the information cross-country inequality: the share of the population aged 15 to 64, the value added of services as a percentage of GDP, the share of total exports and imports of goods and services in GDP, etc. Some authors try to build a classification of indicators dividing them into economic, demographic or social, infrastructural, and other groups, depending on the characteristics of the study [66,67].

We believe that the use of statistical and factor analysis methods on panel data will enable the identification of general and specific factors influencing the regional development of digital technologies in Kazakhstan, controlling the influence that provides the possibility of adjusting the value of the ICT accessibility index and, consequently, the main parameters of digital inequality.

To sum up, an analysis of the scientific literature and the most important indices of the development of information and communication technologies and digitalization suggests that the main factors of the development of the digital economy in Kazakhstan are as follows:

- Information technology costs,
- Number of IT specialists,
- Share of enterprises using computers and having Internet access,
- Share of enterprises using cloud IT services, and
- Proportion of households with Internet access.

In accordance with the purpose of the study and on the basis of the scientific literature analysis, we have formulated the following hypotheses:

H1. *In Kazakhstan, information and communication technologies have penetrated more into the consumer environment than into the activities of economic entities.*

H2. *The values of ICT development indicators are higher in the service-dominated regions of Kazakhstan than in the resource-based ones.*

H3. *Most regions of the country are characterized by a low level of digitalization of labor management and knowledge management processes.*

3. Materials and Methods

The proposed methodology for analyzing the information development processes in society and digitalization of the regional economy in Kazakhstan includes three main blocks:

(1) Research of regional differentiation of Kazakhstan's regions, identification of two clusters of regions, and identification of the causes for digital inequality;
(2) Development of an index of digitalization of the economy and society and subindices for the consumption of digital services by households, the consumption of digital services by organizations, and the digitalization of labor management processes;
(3) Research of the digital inequality determinants.

In the first block, for the research of regional differentiation in terms of digital literacy, public spending on communication services, and the poverty rate, clustering of the regions of Kazakhstan by the share of mining and quarrying in GRP is carried out. The difference in the cluster variable values is used to identify the causes of digital inequality.

In the second block, an Economy and Society Digitalization Index is built based on two-component subindices capturing two dimensions of digital inequality and based on a range of indicators responsible for the possibility of unhindered work, self-education, access to network connections, etc.

Table 1 shows the indicators used to build the subindices.

Table 1. Variables selected for factor analysis.

Legend	Variables	Source
IT_costs	Total information technology costs, million tenge	BNS
IT_specialists	Number of IT specialists, people	BNS
Enterp_comp	Share of enterprises using computers, %	BNS
Internet1	Share of enterprises having access to the Internet, %	Calculations
Cloud_IT	Share of enterprises using cloud IT services, %	BNS
Internet2	Share of households having access to the Internet, %	BNS

Notes: Compiled by the authors. BNS: Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan.

To assess the level of development of the digital economy in the selected regions, we shall use panel data and factor analysis.

To select the optimal set of indicators to describe the object of the research, we used the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy. The criterion shows the adequacy of the factor model to the set of variables that made up this correlation matrix. The factor analysis, the results of which can be interpreted, is also considered successful.

The methodology for developing the Economy and Society Digitalization Index is based on reducing the dimension of the feature space using the principal component method and consists of the following stages:

1. Unification of the data presentation scale and extraction of factors, and
2. Building subindices.

If the generality value is 0, then the factor does not affect the variable. If the generality value is 1, then the variance of the variable is entirely determined by the selected factor.

At the stage of factor extraction, the set of variables is reduced to a smaller set of "artificial" variables called main components, which account for most of the variance of the original variables. To decide which factors should be saved for further analysis, we shall use formal criteria. These are all factors whose individual values exceed 1.

For a more effective interpretation of the solution, after extracting the factors, we needed to apply the Varimax rotation of the original ones, which enabled tracing a clear factor structure and identification of variables marked by high values of correlation coefficients with one factor or another. Correlation is considered strong if the value of the correlation coefficient exceeds 0.7.

The advantage of this index compared to the existing ones is the possibility of taking into account two dimensions of digital inequality: consumption of digital services by households, consumption of digital services by organizations, and digitalization of labor management processes. Therefore, later on, the index can be used to study regional imbalances at the level of development of the digital economy. Differences in the levels of this index in different regions of Kazakhstan will allow us to obtain estimates of interregional digital inequality. It should be noted that regional disparities can also be investigated with the help of two developed subindices used to research the magnitude of digital inequality in access to basic ICTs and wired network services. Our research includes only variables open to public access of the official statistical agency of Kazakhstan.

The third block examines the consequences of the regional digital divide in Kazakhstan and ways to overcome it. Here, the most important direction for overcoming the regional digital inequality suggests several solutions: open resources, open innovations, and implementation of the national strategy.

The balanced data panel of the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, which includes seventeen regions of Kazakhstan surveyed for the period between 2016 and 2021 by six indicators serves as the information base for the research. The number of observations of seventeen regions over six years determines the total volume of the combined sample equal to 100 (Table A1 in Appendix A).

4. Research Results

4.1. Indicators of Digital Development of Resource-Based (Oil and Gas) Regions and Service-Dominated Kazakhstan Regions

To perform a comparative analysis of socio-economic development, and to more fully and accurately identify factors of the digital divide between Kazakhstan territories, we have identified two following clusters:

- Cluster 1: Resource-based (oil and gas) regions of Kazakhstan;
- Cluster 2: Regions of Kazakhstan with the largest share of the service sector in GRP (see Table 2).

Table 2. Kazakhstan's regional development indicators for 2021.

Regions	Share of Mining and Quarrying in GRP, %	Share of Services in GRP, %	Poverty Rate, %	Digital Literacy, Aged 6–74	Population Spending on Communication Services, %
Cluster 1: Resource-based (oil and gas) regions of Kazakhstan					
Atyrau	32.7	25.3	3.3	81.2	3.9
West Kazakhstan	33.2	24.9	4.4	76.4	3.7
Mangistau	35.1	24.4	8.6	78.1	3.9
Mean values	33.7	24.9	5.4	78.6	3.8
Cluster 2: Regions of Kazakhstan with the largest share of the service sector in GRP					
Akmola	2.4	29.8	6.4	68.9	4.1
Aktobe	14.7	31.6	3.7	78.0	3.7
Almaty	0.2	31.9	4.2	86.7	2.9
Zhambyl	1.7	36.9	5.3	78.2	2.8
Karaganda	8.3	26.6	3.2	70.6	3.5
Kostanay	12.2	28.1	3.4	80.8	4.1
Kyzylorda	14.7	34.0	5.5	78.6	2.9

Table 2. *Cont.*

Regions	Share of Mining and Quarrying in GRP, %	Share of Services in GRP, %	Poverty Rate, %	Digital Literacy, Aged 6–74	Population Spending on Communication Services, %
Pavlodar	6.5	26.9	3.9	79.6	3.6
North Kazakhstan	0.3	32.8	5.5	74.8	3.7
Turkestan	6.0	32.8	9.8	76.9	2.5
East Kazakhstan	7.2	30.6	5.5	77.8	3.6
Astana city	0	44.0	2.2	85.4	3.8
Almaty city	0	46.2	5.2	87.2	3.7
Shymkent city	0	40.3	5.5	80.8	3.5
Mean values	5.3	33.8	5.0	78.9	3.5
The Republic of Kazakhstan	13.7 *	53.8 *	5.2	79.6	3.5

Notes: Compiled by the authors. * GDP structure by method of production.

Resource-based (oil and gas) regions include those regions of Kazakhstan in which the share of gross value added from oil and gas production in the structure of the gross regional product in 2021 exceeds 32% and has no special advantages either in the agriculture or service sector.

Service-dominated regions include the rest of Kazakhstan's regions that demonstrate an extremely high share of services in gross regional product for 2021 while the share in industry and agriculture is below average.

Among the main reasons for digital inequality in the selected regions are the following:

1. The population poverty rate both in resource-based (oil and gas) and service-dominated regions. It should be noted that the average poverty rate in Kazakhstan for 2021 was 5.2%. Among the oil and gas-rich regions of Kazakhstan, there is a large gap in the population poverty rate: 3.3% in the Atyrau region and 8.6% in the Mangystau region. We believe the problem of poverty and the increasing incomes of the population is complex. One of the persisting issues is the unequal income distribution. One of the means to combat the unequal income distribution is to improve the redistributive function of the state through taxation.
2. Poor quality of digital infrastructure in a number of regions of the country. In 2021, the Internet speed in the regions of Kazakhstan would stay quite the same, about 20 Mbps. However, an increase in the fiber-optic network coverage area is necessary for remote settlements. It should also be noted that Kazakhstan has a large territory (over 2.7 million square kilometers). This contributes to an increase in the costs of creating telecommunications infrastructure in a remote area and leads to a strong differentiation of digital products and services by territories.
3. The growth of digital literacy in the population of the Republic of Kazakhstan plays a huge role in the period of accelerated global technological development. Successes in this area directly affect the development of human capital and living standards as a whole. In 2021, the lowest level of digital literacy among Kazakhstanis over the age of six was noted in the Akmola region, only 68.9%. The Kazakhstan average was 79.6%. In general, the level of digital literacy needs to be increased in all regions of Kazakhstan.
4. Higher prices for digital products and communication services in resource-based (oil and gas) regions compared to service-dominated regions of Kazakhstan. In this vein, the average resident of a resource-based (oil and gas) region pays 3.8% of his income for communication services monthly while the average resident of a service-dominated region pays 3.5% of income.
5. Different regions show the prevalence of different purposes of using ICT: business, study, entertainment, etc.

6. Different regions of Kazakhstan are characterized by different investment and entrepreneurial activity, which determines the different scales of ICT business development and various financial opportunities for the introduction of digital technologies.

4.2. Factor Analysis Results

After collecting statistical data, we verified their suitability for factor analysis. The results showed the following. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy of factor analysis is 0.517 > 0.5 for the resource-based (oil and gas) regions of Kazakhstan and 0.602 > 0.5 for the service-dominated, which are good results. Our models showed Bartlett's test of 0.000. This also indicates the model's reliability. See Appendix B (Tables A2 and A3) for the results of the KMO measure of sampling adequacy and Bartlett's test.

The results of the initial factor load analysis using the principal component method showed that all the commonalities in the tables are high, which indicates that extracted components represent the variables well.

The stage of factor extraction and Varimax rotation revealed that only two factors in each model at the initial stage of the solution have eigenvalues exceeding one. These factors will serve as the basis for further work. In the model for resource-based (oil and gas) regions of Kazakhstan, together they account for almost 76% of the variability of the initial variables, and 74% in the model for service-dominated regions. This suggests that the process of digitalization in Kazakhstan regions is affected by two hidden factors, but at the same time, there is room for many unexplained variations.

Tables 3 and 4 present two-factor loads (obtained by Varimax rotation) covering six factors for resource-based (oil and gas) regions and service-dominated regions of Kazakhstan.

Table 3. Rotated Component Matrix [a] (Kazakhstan's Resource-Based (Oil and Gas) Regions).

	Component	
	1	**2**
Cloud_IT	0.964	
IT_costs	0.897	
Internet2	0.710	
Enterp_comp		0.945
Internet1		0.925
IT_specialists		0.473

Notes: Compiled by the authors based on IBM SPSS 23 data. a: Rotation converged in 3 iterations. Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

Table 4. Rotated Component Matrix [a] (Kazakhstan's Service-Dominated Regions).

	Component	
	1	**2**
Internet1	0.936	
Enterp_comp	0.928	
Cloud_IT	0.571	0.412
Internet2	0.435	
IT_specialists		0.962
IT_costs		0.928
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.		

Notes: Compiled by the authors based on IBM SPSS 23 data. a: Rotation converged in 3 iterations. Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

Thuswise, the factors presented in Table 3 of the model of resource-based (oil and gas) regions of Kazakhstan can be interpreted as follows:

Component 1 is responsible for the introduction of telecommunication technologies and their use by the regional population. Cloud IT services and their use by enterprises, information technology costs, and public participation in the IT sector's development play a key role here.

Component 2 represents the introduction and use of telecommunications services in organizations, including the increasing share of enterprises using computers, their use of the Internet, and the growth in the number of IT specialists.

The components explain 40 and 36 percent of the total variance, respectively. The measure of sampling adequacy is 0.8.

In Table 4, the factors of the service-dominated region's model can be interpreted as follows:

Component 1 is responsible for the introduction of telecommunication technologies and their use by enterprises and the regional population. The key role here is played by the use of the Internet and computers by enterprises, cloud IT services, and public participation in the IT sector's development.

Component 2 is responsible for developing digital skills among organization employees, including hiring and training specialists, as well as increasing information technology costs.

The components explain 39 and 34 percent of the total variance, respectively. The measure of sampling adequacy is 0.8.

Guided by the experience of the International Telecommunication Union in constructing composite indices to assess the level of development of information and communication technologies in various countries, we propose constructing an Index of Digitalization of the Economy and Society of Kazakhstan regions based on the calculation of two subindices corresponding to the two components described above.

Each of the described subindices is calculated based on the formula of the geometric mean of its factors (due to the majority rule, which gives a more modest estimate compared to the arithmetic mean approach). As a result, the calculated values of subindices of digital consumption by population and organizations in the model of resource-based (oil and gas) regions of Kazakhstan amounted to 0.849 and 0.744, respectively, which conditionally (due to the difference in the set of indicators) characterizes the level of digital consumption by households higher than business consumption. In the model of service-dominated regions, the calculated values of the subindex of digital consumption by the population and organizations and the subindex of digital workforce development and IT costs were 0.681 and 0.944, respectively. The final value of the Digitalization Index was calculated as the geometric mean of its subindices.

Let us consider the descriptive statistics of each of the subindices (Tables 5–8).

Table 5. Subindex of digital consumption by population: Composition and descriptive statistics (Kazakhstan's Resource-Based (Oil and Gas) Regions).

	Minimum	Maximum	Mean	Std. Deviation	Variance
Cloud_IT	0.0	16.4	4.3	5.1	26.3
IT_costs	8514.1	47,072.2	19,549.1	13,286.5	176,533,013
Internet2	81.30	97.9	89.3	4.1	17.3

Note: Compiled by the authors based on IBM SPSS 23 data.

Table 6. Subindex of digital consumption by organizations: Composition and descriptive statistics (Kazakhstan's Resource-Based (Oil and Gas) Regions).

	Minimum	Maximum	Mean	Std. Deviation	Variance
Enterp_comp	50.8	82.8	68.9	7.8	61.0
Internet1	47.2	81.2	66.7	7.7	60.2
IT_specialists	548	2122	1041.4	458.2	210,025.4

Note: Compiled by the authors based on IBM SPSS 23 data.

Table 7. Subindex of digital consumption by organizations and population: Composition and descriptive statistics (Kazakhstan's Service-Dominated Regions).

	Minimum	Maximum	Mean	Std. Deviation	Variance
Internet1	53.0	100.0	73.6	10.5	111.3
Enterp_comp	57.7	100.0	77.3	9.8	96.9
Cloud_IT	0.0	20.5	5.5	4.6	21.4
Internet2	73.2	99.70	89.2	7.5	57.2

Note: Compiled by the authors based on IBM SPSS 23 data.

Table 8. Subindex of digitalization of labor management processes of organizations and IT costs (Kazakhstan's Service-Dominated Regions).

	Minimum	Maximum	Mean	Std. Deviation	Variance
IT_specialists	275.0	15,820.0	2408.1	3516.3	12,364,876.7
IT_costs	1355.7	176,040.1	21,250.8	38,813.9	1,506,521,391.6

Note: Compiled by the authors based on IBM SPSS 23 data.

Most of the indicators included in the subindex of digital consumption by population (Kazakhstan's Resource-Based (Oil and Gas) Regions) are characterized by significant internal homogeneity as the variation in the proportion of households with Internet access does not exceed 17%. This situation indicates that the consumption of digital services by the population on the territory of resource-based regions (oil and gas) is at approximately the same level (with the exception of a few outliers in the sample). It should be noted that the average values of the use of advanced (cloud) technologies are at a fairly low level of 4.3%. This indicates that most of the resource-based regions of Kazakhstan are lagging behind in using the potential of the fifth technological order and creating drivers for the development of the sixth technological order. The greatest scope and variation characterize the indicator of information technology costs, which require significant steps on the part of the state and enterprises to improve them.

The variation in features included in the subindex of digital consumption by organizations is high: by indicators of the share of enterprises using computers and the Internet, it is over 60%. This indicates a significant heterogeneity in the consumption of digital services by organizations. Resource-based (oil and gas) regions of Kazakhstan show high variation in the number of IT specialists as well, and the average value of this factor is at 1041 people.

Service-dominated regions show high variation for all indicators, except for the use of advanced (cloud) technologies. The average values of the share of organizations having access to the Internet and using computers in their activities, as well as the share of households having access to the Internet are fairly high. However, the average values of the use of advanced (cloud) technologies are fairly low, which also indicates that most service-dominated regions of Kazakhstan are lagging behind in using the potential of the fifth technological order.

The subindex of labor digitalization and IT costs is represented by two indicators. IT costs that characterize the level of innovative development of enterprises are responsible for the formation and development of a new type of economy based on knowledge and digital information. The number of IT specialists indicates the degree of the introduction of digitalization processes into the areas of human capital management in organizations. In this vein, we can conclude that most regions of the country are characterized by a low level of digitalization of labor management and knowledge management processes. Considering this fact, digital inequality in the regions of Kazakhstan affects all age categories of those who feel the need to acquire new knowledge.

Table 9 shows the causes and consequences of the digital divide in the regions of Kazakhstan, as well as ways to overcome it.

Table 9. Causes, consequences, and ways to overcome digital inequality in the regions of Kazakhstan.

Digital Inequality in the Regions of Kazakhstan		
Causes	**Consequences**	**Ways to Overcome**
- poverty rate, - poor quality of digital infrastructure, - low level of digital literacy, - high prices for digital products and services, - different purposes of using ICTs, - different regional investment and entrepreneurial activity, - limited access to knowledge and information.	- the lag of most of the regions of Kazakhstan in using the potential of the fifth technological mode and creating drivers for the development of the sixth technological mode, - knowledge and information asymmetry, - low innovation ability, - low level of digitalization of labor and knowledge management processes.	- open resources, - open innovation, - implementation of the national strategy.

Note: Compiled by the authors.

Our study confirms that the regional digital divide directly affects the knowledge economy and digitalization of labor and knowledge management processes [35,36]. This leads to additional barriers to entrepreneurship and knowledge asymmetry. Some regions of Kazakhstan have an advantage due to better access to ICTs and development opportunities. Consequently, these regions are more able to receive, use, and transfer new knowledge and information. This leads us to the conclusion that digital inequality has an impact on the opportunity and ability of the regions of Kazakhstan to conduct research and development and, therefore, it affects the process of creating and distributing innovations. Bridging the digital divide provides less developed regions of Kazakhstan with additional opportunities for their socio-economic development. We propose the following solutions to overcome the digital divide and bridge the existing gap:

- Open resources,
- Open innovation, and
- Implementation of the national strategy.

Open innovations create additional opportunities for obtaining new knowledge and additional tools and ideas that can lead to bridging the digital divide [68,69]. However, the application of an open innovation model in the practice of Kazakhstan is just beginning, or rather it is a completely new business direction. The application of this paradigm is complicated primarily by the underdevelopment of factors in Kazakhstan, which gave rise to it 30 years ago in the West.

The problems hindering the implementation of the open innovation model in the Republic of Kazakhstan can be divided into the following three blocks:

- Legal issues: The legislative side of the issue has not been resolved; the necessary legal conditions for the promotion of this model have not been created. This includes an undeveloped venture capital market, a large bureaucracy, and the corruption of the authorities. Kazakhstan also has serious legal problems in the field of intellectual property. Developers of new projects are not legally protected.
- Difficulties arising in connection with the economic background of the issue: the raw material orientation of the economy, low scientific and human resources potential, lack of experienced and "mobile" professionals, lagging behind global innovation processes, changeable and dependent on global trends market conditions, etc.
- Difficulties of the administrative plan. Kazakhstan has not worked out the mechanisms of interaction between private businesses and institutions. As a result, it is necessary to go to various kinds of tricks and look for loopholes in the law. In addition, there are many other problems in this direction that hinder not only the application of the open innovation model in our country, but also the development of business in general,

which include an undeveloped innovation infrastructure, government agencies, in particular, development institutes and innovation laboratories, whose role is to create conditions for the development of innovation in general.

Kazakhstan's successful functioning in the conditions of open innovation requires a combination of a national modernization strategy and a technological breakthrough strategy depending on the industry and the territory of the country.

The analysis allowed us to identify the factors of the digital divide between resource-based (oil and gas) regions and service-dominated regions of Kazakhstan [25]. For example, the average values of the studied indicators were higher in service-dominated regions than those in resource-based (oil and gas) regions:

- Information technology costs by 1701.7 million tenges,
- The number of IT specialists by 1366.7 people,
- The share of enterprises using computers by 8.4 percentage points,
- The share of enterprises using Cloud IT services by 1.2 percentage points, and
- The share of enterprises having Internet access is 6.9 percentage points.

It is noteworthy that the share of households having Internet access in the two regions of Kazakhstan is the same—89.2.

The analysis of the calculated subindex values showed that the indicators providing regional differentiation within the consumption of telecommunications services by households and organizations are indicators that, to a greater extent, characterize the development of digitalization and datafication processes, such as the use of mobile Internet, the development of electronic commerce, the use of cloud services, and the hiring and training of personnel via the Internet [1,2,56]. This brings us to the conclusion that there is a need for a regional policy to improve the quality of the mobile network and the development of digital skills among the population.

5. Discussion

The results of the analysis of the digital divide in resource-based (oil and gas) regions of Kazakhstan and service-dominated regions did not allow any of the research hypotheses put forward to be refuted.

Our study confirmed that in Kazakhstan, information and communication technologies have penetrated into the consumer environment to a greater extent than into the activities of economic entities. The consumption of digital services by the local population is at approximately the same level with the exception of a few outliers in the sample. The population's participation in e-commerce requires both significantly more developed digital skills and greater network bandwidth, and the availability of modern mobile devices [9,22,24,25]. The average values of indicators characterizing the degree of companies' web presence and the usage of advanced (cloud) technologies are fairly low. This situation indicates that most of the regions of Kazakhstan are lagging behind in using the potential of the fifth technological mode and creating drivers for the development of the sixth technological mode. Regional analysis of such indicators and their comparison with the values in other regions of Kazakhstan should become a mandatory item for regional policy on regional economy digitalization.

Confirmed was the hypothesis that ICT development indicators are higher in the service-dominated regions of Kazakhstan than in those resource-based (oil and gas). Raw material specialization determines regional imbalances in the level of economic and digital development [28,70–72]. Resource-based (oil and gas) regions attract mobile and skilled labor resources and investments, thereby turning into leading centers according to certain socio-economic indicators [30]. On the flip side, difficult climatic conditions and the high cost of infrastructure maintenance hinder their sustainable socio-economic development and add to the growth of digital inequality. Our previous research [73] has shown that the results of an analysis of resource-based regions of Kazakhstan indicate a low level of innovation activity, and the instability of regional development. This predetermines the strengthening of the search for factors and new tools and measures to disclose the existing potential and detailed research of open innovation dynamics to create and implement innovation in regions where oil and gas production predominates in the economy.

The majority of Kazakhstan's regions are characterized by a low level of digitalization of labor management and knowledge management processes, which confirms the third hypothesis of our study. The subindex of labor management process digitalization in organizations and IT costs is represented by two indicators, none of which exceeds 40%. However, such an indicator as the number of IT specialists depicts the formation and development of a new type of economy based on knowledge and digital information [15,22]. Digital development of human capital should become an important task for the state and most organizations.

To ultimately overcome the regional digital divide in Kazakhstan, we have proposed several solutions to reduce it: open resources, open innovations, and implementation of the national strategy. In our study, we reveal the relationship between the digital divide and open innovation in over a dozen papers on open innovation dynamics.

Accordingly, the penetration of information and communication technologies is confirmed to a greater extent in the consumer environment than in the activities of entrepreneurs of Kazakhstan (H1), as well as the level of penetration of information and telecommunication technologies into the economy of service-dominated regions than in resource-based (oil and gas) ones. It should be noted that most regions of the country are characterized by a low level of digitalization of the processes of workforce management and knowledge management (H3).

6. Conclusions

The analysis allowed us to identify the factors of the digital divide between resource-based (oil and gas) regions and service-dominated regions of Kazakhstan. For example, the average values of the studied indicators were higher in service-dominated regions than those in resource-based (oil and gas) regions:

- Information technology costs by 1701.7 million tenges,
- The number of IT specialists by 1366.7 people,
- The share of enterprises using computers by 8.4 percentage points,
- The share of enterprises using Cloud IT services by 1.2 percentage points, and
- The share of enterprises having Internet access is 6.9 percentage points.

It is noteworthy that the share of households having Internet access in the two regions of Kazakhstan is the same—89.2.

The analysis of the calculated subindex values showed that the indicators providing regional differentiation within the consumption of telecommunications services by households and organizations are indicators that to a greater extent characterize the development of digitalization and datafication processes, such as the use of mobile Internet, the development of electronic commerce, the use of cloud services, and hiring and training of personnel via the Internet. This brings us to the conclusion that there is a need for a regional policy to improve the quality of the mobile network and the development of digital skills among the population.

Descriptive statistics of the calculated subindex values allowed us to draw a number of conclusions. Firstly, the population of the regions of Kazakhstan is characterized by a fairly homogeneous high level of consumption of telecommunications services, which indicates their availability. Secondly, the majority of economic entities throughout the country have successfully passed the first stage of digitalization, which consists in the use of Internet technologies, but not all of them are characterized by a trend towards the datafication of business processes. Third, the digital development of human capital remains an important challenge for most organizations.

Regional analysis of such indicators and their comparison with the values in other regions of Kazakhstan should become a mandatory item of regional policy on the digitalization of the regional economy.

The following can be proposed as measures to overcome (reduce) digital inequality in the regions of Kazakhstan:

- Inclusion of goals and objectives related to the development of digital technologies, products, and services in regional development programs;
- Development of global information networks and providing regions with access to them as part of the open innovation concept;
- Development of computerization and programming systems considering specific features of the digital development of individual regions;
- Development of platform methods of business organization in the regions;
- Development of computer literacy of the population, including on the basis of regional centers of digital competencies;
- Development of e-government functions in the regions;
- Expanding the scope of application of Smart City technologies.

The digital divide in the regions of Kazakhstan creates an asymmetry of information and knowledge and, therefore, adversely affects the production and dissemination of information and knowledge, which, in turn, negatively affects the innovation processes. The impact of the digital divide in Kazakhstan's regions on innovation is clear. Digital inequality can be reduced by using open resources and innovation to exploit existing ones and create new ideas.

The conducted research provides a basis for further work. Future research may focus on the following:

- First, on expanding the scope of this study to obtain more accurate results;
- Second, on increasing the variables for analysis since the factors we have obtained explain only 76% of the total variance for resource-based (oil and gas) regions of Kazakhstan and 73% for service-dominated regions of Kazakhstan. This means that the remaining 24% and 27% of the variance are factors that are still to be found;
- Third, to confirm the reliability of the results obtained, it is necessary to use other statistical methods of analysis.

We believe that further research of the regions of Kazakhstan based on the proposed Economy and Society Digitalization Index will provide a more thorough and precise identification of the factors of the digital divide between different territories. Regional analysis of such indicators and their comparison with the values in other regions of Kazakhstan should become a mandatory item in a regional policy on regional economy digitalization.

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Appendix A

Table A1. Data for analysis.

Region	Year	IT_Costs	IT_Specialists	Enterp_Comp	Internet1	Cloud_IT	Internet2
Atyrau region	2016	8514.1	1510	71.1	66.7	1.2	85.6
	2017	13,464.1	1781	70.9	67.6	0.1	88.4
	2018	38,711.7	2122	66.7	64.7	7.5	93.6
	2019	47,072.2	1330	82.8	81.2	12.5	93.9
	2020	39,715.9	1399	76.7	74.4	13	93.8
	2021	45,516	1031	76.5	73.1	16.4	93.76
West Kazakhstan region	2016	10,705.3	926	74.9	71.7	0	87.4
	2017	15,164.3	1092	67.4	65.5	1.2	81.3
	2018	14,739.2	657	53.9	52.6	4.7	88.6
	2019	16,091.9	758	64.5	63.4	5.5	88.9
	2020	18,365.7	709	62.1	60.7	2.3	89
	2021	20,022.6	548	65.4	64.6	7.9	89.45
Mangistau region	2016	8825.5	828	50.8	47.2	0.1	82.3
	2017	11,639.9	1414	72.8	71	0.1	86.7
	2018	11,655.4	848	71.5	68	0.4	88.1
	2019	8611.7	696	70.1	68.3	0.8	90
	2020	14,222.6	549	68.9	68.3	0.8	90.2
	2021	8846.5	548	73.4	71.9	4	97.94
Akmola region	2016	2102.6	660	67	63.8	0.4	73.2
	2017	3365.9	655	66.5	63.1	3.8	73.7
	2018	19,674.3	658	70.5	67.4	6.5	75.7
	2019	3275.3	540	71.8	68.9	7.4	81.5
	2020	3701.6	503	75.9	72.2	12.6	85.6
	2021	5186	613	78.8	75.7	10.3	89.21
Aktobe region	2016	5529.1	1253	78.8	72.3	0.6	82.4
	2017	5683.7	850	78.1	73.8	3.4	86
	2018	10,365	824	77.2	74.5	3.1	90.8
	2019	6977.8	882	79.5	76.1	10.2	91.7
	2020	8533.4	968	74.2	71.2	1.9	94
	2021	8201.1	1066	78.6	76.2	5.4	94.45
Almaty region	2016	3640.7	1230	70.2	64.6	0.6	95.1
	2017	4244.8	924	68.7	64.7	1.2	92.7
	2018	5295.2	707	69	66.5	3.3	96.4
	2019	6802	617	71.2	69.9	3.9	97
	2020	5183.9	707	69.7	66.7	6.9	97.2
	2021	5092.1	768	72.8	69.9	7.4	98.73

Table A1. *Cont.*

Region	Year	IT_Costs	IT_Specialists	Enterp_Comp	Internet1	Cloud_IT	Internet2
Zhambyl region	2016	2390	558	69.4	62.5	0.6	83.6
	2017	2191.8	429	68.4	62.5	3.6	89.9
	2018	2044.9	475	66.7	62.6	2.7	92.5
	2019	2028	359	73	69.1	4.9	94.2
	2020	2347.9	299	77.2	73	6.2	95.9
	2021	2407.5	441	74.3	71.6	7.4	96
Karaganda region	2016	6939.5	2293	78.1	72.5	0	74
	2017	7730.9	1987	80.9	76.8	5.9	78.6
	2018	10,163.8	1976	84.6	81.4	7.2	78.3
	2019	11,711.4	2416	91.6	89.5	6.9	86.4
	2020	13,148.9	2434	95.1	92.9	15.9	89.9
	2021	20,428.4	1732	88.1	86.6	18.9	94.27
Kostanay region	2016	2779.8	1244	76.1	69.7	1	78.3
	2017	3200.3	1363	77	72.3	4.3	79.9
	2018	3709.8	1007	74.6	71	5.2	80.3
	2019	3390.5	825	79.1	76	7.9	83.4
	2020	5642.3	1216	87.2	82.2	6.8	87.5
	2021	5967.9	779	76.6	73.3	6.7	88.15
Kyzylorda region	2016	2167.8	669	68.1	60.6	0.3	96.9
	2017	3290.5	568	65.3	59.7	1.2	98.8
	2018	2761	501	65	60.3	0.4	99.6
	2019	8716.7	977	71.8	67.8	2.8	99.7
	2020	8218.1	1187	72.2	67.9	4.4	99.7
	2021	7932.1	1052	68.3	64.1	5.4	98.04
South Kazakhstan region	2016	5297.4	1468	57.7	53	0.1	87.1
	2017	6253.8	1262	60.4	57.1	2	91.7
Pavlodar region	2016	6673.4	1445	75.9	70.5	0	88.4
	2017	13,687.6	1684	70.9	65.1	3.4	79
	2018	9423	1205	71.4	66.7	3.2	83.8
	2019	10,285.7	1019	78.2	73.3	0	90.9
	2020	11,753.1	891	74.5	71.8	6.5	91.8
	2021	13,533.3	1193	79.7	77.9	8.3	95.59
North Kazakhstan region	2016	1355.7	698	68.8	63.5	1.8	80.3
	2017	2447.2	652	71.3	67.2	2.7	78.9
	2018	2113.5	533	70.3	66.9	5.3	81.9
	2019	2300.8	484	71.5	69.3	6	82.6
	2020	3194.3	397	81	79.8	6.5	89.5
	2021	3505.8	614	75.5	74	11.5	89.7

Table A1. *Cont.*

Region	Year	IT_Costs	IT_Specialists	Enterp_Comp	Internet1	Cloud_IT	Internet2
East Kazakhstan region	2016	12,898.6	1495	69.9	62.4	0.8	73.3
	2017	13,376.9	1700	67.3	63.9	4.6	73.3
	2018	12,752.5	1470	69.1	64.8	1.7	79.7
	2019	9768.8	1571	73.1	69.3	5.4	83.1
	2020	11,062.3	4448	71.6	69.1	4	85.8
	2021	16,742	1502	65.6	63.2	7.6	89.54
Astana city	2016	83,603.8	7611	82.2	79.8	0.4	99
	2017	71,930.2	7542	67.9	66.4	5.1	93.3
	2018	103,365.2	9302	99.5	97.1	9.6	95.6
	2019	110,211	8554	99.9	97.6	10.3	99
	2020	150,111.7	9325	99.3	97.5	6.1	99.2
	2021	176,040.1	12,006	100	99.1	15.8	99.31
Almaty city	2016	106,103.3	10,123	87.2	83.8	0.1	88
	2017	172,271.6	13,301	80.3	77.5	10.2	87.4
	2018	53,088.3	10,776	77.9	76.1	10.5	89.4
	2019	81,303.7	10,409	84.7	82.5	15.4	89.7
	2020	83,940.7	10,620	88.5	86.5	14.7	92.4
	2021	93,988.4	15,820	79.5	77	20.5	93.72
Turkestan region	2018	2827.4	275	77.8	71.3	0.5	93.3
	2019	3236.7	281	89	78.1	0.3	96.7
	2020	5184.9	306	86.3	79.4	0.4	98.4
	2021	4446.5	340	80.9	79.2	1.1	98.96
Shymkent city	2018	2527.3	980	97.4	95.9	6	90.7
	2019	5928.7	1105	100	97.3	9.8	91.3
	2020	4601.2	684	100	100	9.7	91.1
	2021	5264.9	1168	89.9	86.8	9.6	96.17

Appendix B

Table A2. Results of factor analysis of the model for resource-based (oil and gas) regions of Kazakhstan.

KMO and Bartlett's Test		
Kaiser–Meyer–Olkin Measure of Sampling Adequacy.		0.517
Bartlett's Test of Sphericity	Approx. Chi-Square	108.683
	df	15
	Sig.	0.000

Table A2. *Cont.*

Communalities		
	Initial	**Extraction**
IT_costs	1.000	0.873
IT_specialists	1.000	0.235
Enterp_comp	1.000	0.958
Internet1	1.000	0.938
Cloud_IT	1.000	0.945
Internet2	1.000	0.625

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.45	57.56	57.56	3.45	57.56	57.56	2.39	39.93	39.93
2	1.12	18.67	76.23	1.12	18.67	76.23	2.17	36.30	76.23
3	0.997	16.62	92.86						
4	0.370	6.17	99.03						
5	0.052	0.866	99.895						
6	0.006	0.105	100.00						

Notes: Compiled by the authors based on IBM SPSS 23 data. Compiled by the authors based on IBM SPSS 23 data. Extraction Method: Principal Component Analysis. Compiled by the authors based on IBM SPSS 23 data. Extraction Method: Principal Component Analysis.

Table A3. Results of factor analysis of the model for service-dominated regions of Kazakhstan.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.602
Bartlett's Test of Sphericity	Approx. Chi-Square	522.457
	df	15
	Sig.	0.000
		Communalities
	Initial	**Extraction**
IT_costs	1000	0.929
IT_specialists	1000	0.964
Enterp_comp	1000	0.912
Internet1	1000	0.943
Cloud_IT	1000	0.497
Internet2	1000	0.194

Table A3. *Cont.*

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.37	56.31	56.31	3.37	56.31	56.318	2.360	39.33	39.33
2	1.06	17.67	73.99	1.06	17.67	73.993	2.079	34.65	73.99
3	0.897	14.94	88.93						
4	0.584	9.734	98.67						
5	0.070	1.169	99.84						
6	0.010	0.158	100.0						

Notes: Compiled by the authors based on IBM SPSS 23 data. Compiled by the authors based on IBM SPSS 23 data. Extraction Method: Principal Component Analysis. Compiled by the authors based on IBM SPSS 23 data. Extraction Method: Principal Component Analysis.

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