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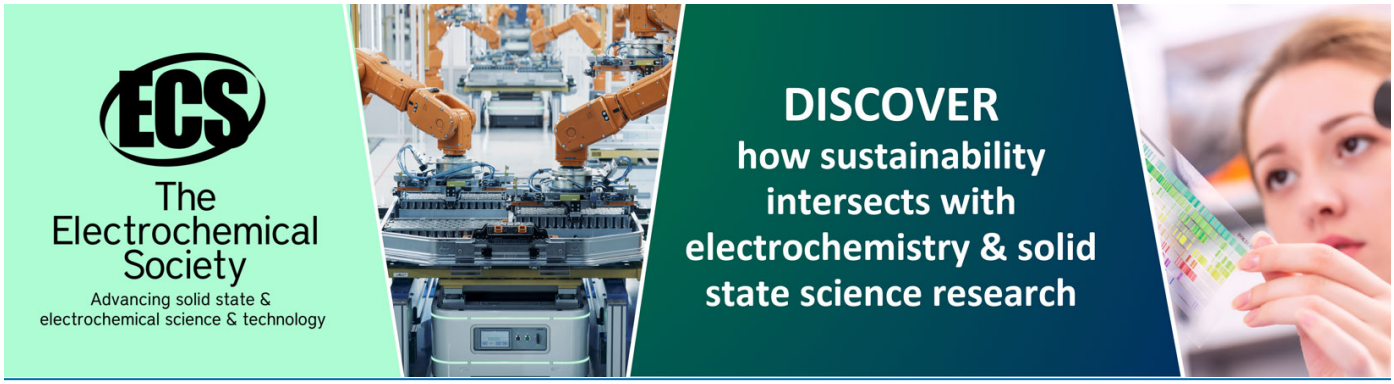

The study of current situation in the development of information and telecommunication networks within the Eastern Siberia territory

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Abstract. The territory of Eastern Siberia (Siberian Federal District) is characterized by non-homogeneous location of production and information facilities. The climate in most of the territory is sharply continental. There is widespread permafrost, mountain terrain and low population density in some places. Thus, these factors indicate that it is impractical to develop some parts of this territory. However, a number of industrial cities are located in the northern territories, thus supporting the development of ICT to link with regional centers. The article analyzes the current situation in the development of information and telecommunication networks within the territory of the regions of Eastern Siberia based on aggregated groups of statistical indicators in the period from 2005 to 2018. Drawing on the correlation analysis, a linear relationship was revealed between the selected statistical indicators. A comparative analysis of one of the statistical indicators was carried out according to all ten actors of Eastern Siberia. The diagram shows the ratio of the level of development within the territory of each region, which makes it possible to determine the level of development of information and telecommunication networks in detail.

In the context of examining the development of the territory, Russian economists use the term "spatial connectivity", which involves the selection of quantitative indicators and their aggregation into various groups to simplify the mathematical operations. Academician M.A. Pogosyan notes that the spatial connectivity is a means of solving two strategic tasks: overcoming domestic socio-economic imbalances in the regions and strengthening the foreign economic and foreign policy positions of Russia (a comprehensive scientific and technological program "Spatial Connectivity") [1].

The study of the connectivity properties of economic space can provide significant progress in solving the problem of asymmetries in regional development, as reflected in a number of controversies [2,3]. These controversies can be determined by a set of criteria: settlement ("city / village" problem), placement of funds and the movement of migration flows ("center / suburb" and "metropolis / province" problems), location of production (the problem of disproportion between geographical ranges, for example North / South), etc. [4,5].

The increase of spatial connectivity of Eastern Siberia regions is attributed, on the one hand, to the availability of a single and integral national economic complex, within which solution of connection reduces the efficiency of economic activity, destroying the reproducibility chain in the territory. On the other hand, an integral part of the current stage of development is the creation and strengthening of regional platforms that claim the status of active players not only in the national but also in the global market. In this regard, it seems relevant to study the properties of economic space and spatial connectivity, as well as to take into account the specificities of the regions in management of regional development [3,6,7]. Connectivity as a property of economic space determines the spatial distribution of resources and the achievement of economic benefits from their use.

Siberia and the Far East in this context require special approaches that differ from the central and southern regions of the country. For research we use the statistical collection "Regions of Russia" (link), a group of aggregated indicators "Information and telecommunication technologies" for 10 actors of the Siberian Federal District (Eastern Siberia) for the period from 2005 to 2018. The rest of Eastern Siberia is highly urbanized, which allows on the basis of the study to claim that some regions are slightly lagging behind the national average in the development of information and telecommunication networks.

For the study, ten regions of the Siberian Federal District have been considered. We have labeled them with the letter R, where each region has its own number: R1- Krasnoyarsk Region, R2- Irkutsk Region, R3-Tomsk Region, R4-Novosibirsk Region, R5-Omsk Region, R6-Altai Region, R7-Altai Republic, R8-Kemerovo Region, R9-Khakassia Republic and R10-Tyva Republic. To conduct a quantitative analysis, we use statistical indicators and also label them with letter Q with a sequence number:

- The proportion of the households with broadband Internet access in the total number of households (%) – Q1.
- The proportion of the population using the Internet in the total population (%) – Q2.
- The proportion of organizations using broadband Internet access in the total number of surveyed organizations (%) – Q3.
- The number of connected user's mobile devices per 1000 of the population (at the end of the year), it is measured in pieces – Q4.
- The number of active broadband Internet users per 100 of the population (at the end of the year), fixed Internet units – Q5.
- The number of active broadband Internet users per 100 of the population (at the end of the year), mobile Internet units – Q6.

Not until 2014 were indicators such as "the proportion of the households with broadband Internet access in the total number of households" (it is calculated as a percentage) and "the proportion of the population using the Internet in the total population" (it is calculated as a percentage) used. The rest of the indicators are taken into account from 2005 to 2018, excluding the crisis years of 2008 and 2009. Some indicators exclude data for 2005 and 2010. This is explained by the fact that Russian statistics of that time did not have objective data on them, as well as the collection and calculation methods.

Consider the dependence of the proposed statistical indicators [8] based on correlation analysis using the example of the Krasnoyarsk Region (table 1).

Table 1. Statistics on the Krasnoyarsk Region by the aggregated group "Information and telecommunication technologies".

Year	Q1	Q2	Q3	Q4	Q5	Q6
2005	0	0	0	791.8	0	0
2010	0	0	48.7	1720.9	0	0
2011	0	0	57.8	1546.7	10.1	53.5
2012	0	0	71.7	1646.8	13.6	64.1

2013	0	0	76.5	1722.7	15	75.2
2014	63.1	70.7	77.8	1655.4	15.2	62.8
2015	62.2	71	80.6	1707.7	15.7	71.2
2016	62.6	75.6	81.6	1658.3	14	76.2
2017	63.9	79.4	82.3	1798.9	13.6	75.6
2018	66.8	82	85.6	1748.9	15	82.2

Apply a correlation matrix to identify patterns and level of the relationship between statistical indicators that are random values. To do this, we calculate the pair correlation coefficients using the following formula:

$$r_{xy} = \frac{\sum_{t=1}^{n}[(x_t - \bar{x_t}) * (y_t - \bar{y_t})]}{\sqrt{\sum_{t=1}^{n}(x_t - \bar{x_t})^2 \sum_{t=1}^{n}(y_t - \bar{y_t})}}$$

Analysis results. Within the output range, we obtain the correlation matrix (table 2).

Table 2. Correlation matrix results.

Correlation matrix results	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Q1	1	0	0	0	0	0
Q2	0.998366292	1	0	0	0	0
Q3	0.621430912	0.623092605	1	0	0	0
Q4	0.413896497	0.41830794	0.913116463	1	0	0
Q5	0.599272548	0.593530143	0.882586408	0.63751586	1	0
Q6	0.605348686	0.61140268	0.887374812	0.649245547	0.97632307	1

Interpretation of the results. It is implied that the empty cells in the upper right half of the table contain the same correlation coefficients as in the lower left (which are arranged symmetrically relative to the diagonal). The table shows that the correlation between the Q1 indicator (the proportion of the households with broadband Internet access in the total number of households) and Q2 (the proportion of the population using the Internet in the total population) is 0.99, which shows the strongest direct link (linear relationship). There is also a direct relationship between Q4 (the number of connected user's mobile devices per 1000 of the population (at the end of the year) and Q5 (the number of active broadband Internet users per 100 of the population) and it is 0.63. Whereas the relationship between Q3 (the proportion of organizations using broadband Internet access in the total number of surveyed organizations) and Q4 is less marked, and it is 0.41. Consider the indicators graphically in the form of a diagram (figure 1).

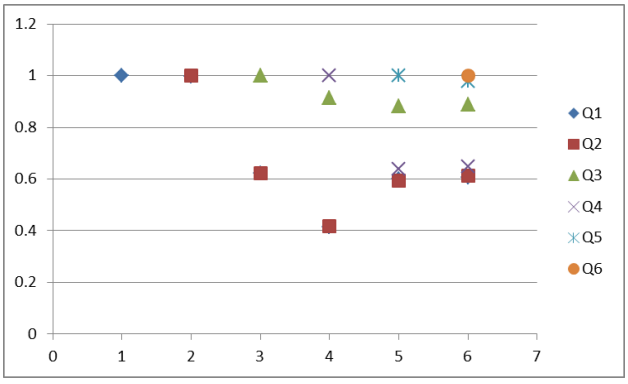

Figure 1. Correlation matrix results indicating a linear relationship of the selected statistics.

The picture shows that all indicators have only a direct correlation. Consider in detail the state of development of the Eastern Siberia territory according to the Q1 indicator – The proportion of the households with broadband Internet access in the total number of households. This indicator is measured as a percentage. To do this, it is necessary to analyze the following statistics and determine the mean of sample (table 3).

Table 3. Statistics on the indicator "The proportion of the households with broadband Internet access in the total number of households (%) by mean of sample.

Year	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
2014	63.1	63.6	59.1	68.1	78	55	55	63.9	61.2	44.8
2015	62.2	65.3	64.3	65.2	76.1	63.3	63.4	61.4	74.9	52.3
2016	62.6	67.6	62.3	69.8	78.1	62.6	62.9	63.2	63.1	57.9
2017	63.9	63.9	69	68	82.9	75.7	75.7	66.9	58.3	81.7
2018	66.8	69.9	63.7	74.5	84.1	84.4	84.4	66.4	54.5	87.4
Mean of sample	66.8	66.06	63.68	69.12	79.84	68.22	68.28	64.36	62.4	64.82

To simplify visual perception, we will convert the obtained mean of sample into a percentage and make a graphic out of that (figure 2).

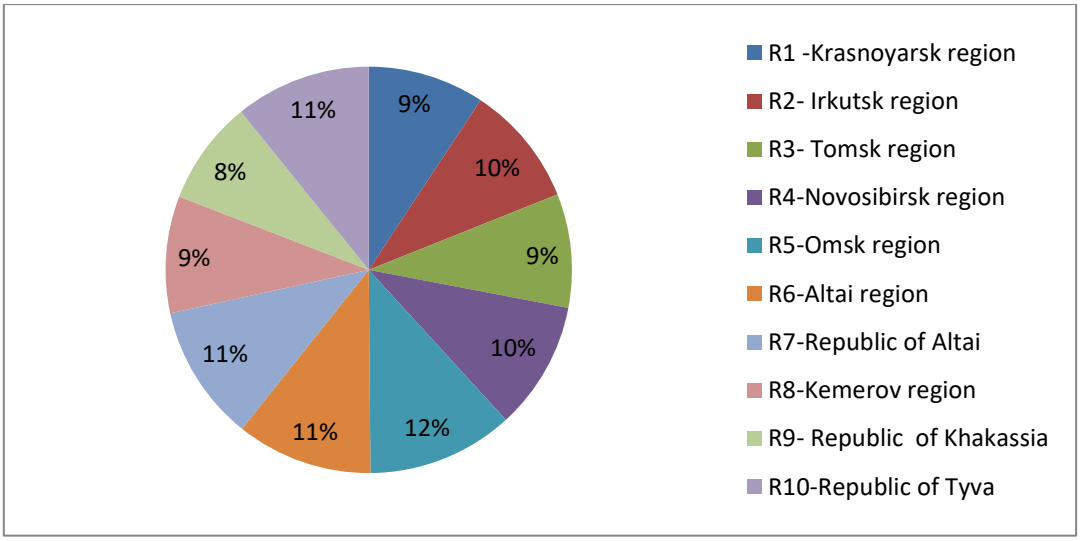

Figure 2. The development status of information and telecommunication networks within the Eastern Siberia territory according to the statistical indicator "The proportion of the households with broadband Internet access in the total number of households" from 2014 to 2018.

The figure shows that the most developed regions to exploit the large-format Internet are the Omsk region, the Republic of Tyva, the Republic of Khakassia, the Altai Republic (over 10%). However, it cannot be considered that the socio-economic development of regions, which value is below 10%, is associated with the vast northern territories. At the same time, the listed regions have an area 2 times less than the area of the Krasnoyarsk region and the Irkutsk region, despite the fact that the Irkutsk region and the Krasnoyarsk region are donor regions, which gross regional product is much higher than the indicators of these regions.

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