Interrelation of levels of development of innovation potential and transport ecosystem of regions

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Abstract. The article analyzes the impact of innovative approaches to the formation of transport infrastructure on the level of development of innovation potential of regions, specifies the stages of formation of innovation regional systems, systematizes the approach to ranking of Russian regional innovation indices (RRII) by thematic sub-indices for the pre-pandemic period 2019 - 2020. The author notes that there is no consensus among domestic scientists about the directions of significance of a functioning and developing transport system on the region's economy and ecosystem. On the one hand, innovations in the transport sphere influence the dynamics of income growth of the regional economy due to the reduction of costs of the transport and logistics system, increase in the speed and volume of passenger and freight traffic, growth of investment attractiveness of the region, diffusion of innovations and growth of labor productivity. However, the accompanying growth of agglomerations leads to increased density of traffic flows, environmental problems and aggravation of transport safety issues. In this connection the problems of introduction of innovations in transport, solved within the programs of increasing the level of safety of transport ecosystem of regions, formation of a qualitatively new level of development of regional innovation potential, have a high degree of influence on the regional socio-economic systems. Thus, innovation, including in the transport sector, can be considered an indispensable condition for the development of regional ecosystem. Keywords: innovation, innovation potential of the region, transport infrastructure, innovative projects in the field of transport.

1 Introduction

The level of development of the national, including regional economy, depends, among other things, on the effectiveness of the operation of the transport infrastructure of the territory, taking into account the environmental factor. Note that the high congestion of roads and railroads, leading, among other things, to pollution of the terrain and disturbance of the ecosystem of the territory, lead the scientific community to search for new approaches to the
formation of innovative solutions and technical developments aimed at improving transport efficiency for the regions.

Note that the practice does not show a direct link between the levels of development of transport infrastructure and the economy in the regions. This is due to a number of mutually exclusive factors:

1. Highly developed transport infrastructure with high load factors and prompt solution of logistical problems significantly increases trade turnover, creates jobs and, as a result, forms the vectors of regional production development;

2. However, the accompanying growth of agglomerations leads to an increased density of traffic flows, environmental problems and aggravation of transport safety issues.

In this connection the problems of innovations introduction in transport, solved within the limits of programs of increase of a level of innovative development of regions, formation of qualitatively new level of development of regional innovative potential, have a high degree of influence on regional socio-economic systems. Thus, innovation, including in the transport sector, can be considered an indispensable condition for regional development.

2 Materials and methods

Schumpeter [1] in his works writes that the development of an economic entity depends primarily on the implementation of qualitative changes, rather than quantitative ones. In his opinion, in addition to the growth of production secured by monetary injections, it is also necessary to carry out qualitative growth, which is almost always supported by:

- the use of new raw materials;
- entering new product markets;
- introduction of new technologies in the production process;
- launch of a new product, etc.

The works of N.D. Kondratiev [2,3] reveal the thesis that the transition from one economic cycle to another occurs due to scientific and technological progress and the accumulated innovation experience, which is gradually transformed into ready-made solutions, changing the way of everyday life.

Currently, innovation is considered in the scientific community as the main factor of economic development. It can be confirmed by Glazyev’s theory of long-term economic development [4,5,6], according to which the main technological ways are distinguished, each of which is based on certain technologies. The transition to a new technological mode is accompanied by a sharp jump in production efficiency and, accordingly, by an increase in innovative activity.

However, ensuring high innovative development is at the same time an important and difficult task. According to Y. V. Yakovets [7], there are so-called anti-innovations and pseudo-innovations, which significantly slow down the process of economic development. In this connection, it seems necessary to implement improvements in the field of assessing the effectiveness of innovative development.

Considering algorithms of management of innovations development, we note that they consist of strategy and investment policy, based on it. These stages form a chain of interconnected factors forming successful investment activity, which can be seen in figure 1 [8].

![Fig. 1. Stages of the innovation system formation.](image-url)
Stages are associated not only with the process of creating and implementing innovations, but also with their development and improvement. Many of the above are performed not only at a certain stage, but also during the whole activity, among them coordination, stimulation, control. They are inherent in the work throughout, but their greatest manifestation occurs in the specified stage. If all stages are followed and the right policies are in place, a favorable innovative environment emerges. In this environment, unique ideas and technologies can actively develop, which, if properly managed and stimulated, allows innovations to be generated. The process of creating innovation is quite complex, it is not enough to have an idea, it is necessary to make calculations, to study the problems associated with innovation. Testing is difficult enough, often without proper support of investors or social institutions involved in the innovative environment to produce such expensive operations as testing and production is simply impossible. Sales and consumption of innovations is also a very difficult process in countries with underdeveloped innovation policies or in Third World countries.

The high level of development of national and regional economies, first, gives territories the opportunity to form their own investment capital, which can be invested in the formation and diffusion of innovations, including in the formation of the transport ecosystem. On the other hand, a developed economy of territories attracts external investment capital interested in the implementation of innovations. Thus, the scientific community is currently discussing the expediency of launching innovative transport projects in developed macro-regions, such as the Hyperloop project by the creator of PayPal and Tesla Motors Elon Musk - a high-speed vacuum train - a capsule moving along the highway inside a steel tube on air cushions; a bus project by the Chinese Shenzhen Huashi Future Parking Equipment, capable of moving parallel to the movement of urban transport and over it on monorails using the energy of solar panels installed on its roof; a network project by the Chinese company Shenzhen Huashi Future Parking Equipment.

At the same time, when assessing the impact of innovative approaches to the formation of transport infrastructure on the level of development of innovation potential of regions, one can find both similarities and differences when considering the most relevant current methodologies for assessing the level of innovation development of regions.

Of interest is the methodology used to determine the leaders of innovative development to identify applicants for state subsidizing of innovative activities, based on the system of thematic sub-indices [9]:

- ISEC: socio-economic conditions of innovation activity;
- IEA – export activity;
- ITP: technological potential;
- IA: innovative activity;
- IAQ: innovation policy quality.

Ranks of Russian regional innovation indices (RRII) by thematic sub-indices for the pre-pandemic period 2019 - 2020 are shown in Table 2.
Table 2. Ranks of Russian regional innovation indices (RRII) by thematic sub-indices for the pre-pandemic period 2019-2020.

<table>
<thead>
<tr>
<th>PLACE IN RATING</th>
<th>ISEC</th>
<th>ISTP</th>
<th>IA</th>
<th>IEA</th>
<th>IAQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moscow</td>
<td>1</td>
<td>6</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Saint-Petersburg</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>The Republic of</td>
<td>4</td>
<td>17</td>
<td>4</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>Tatarstan</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>39</td>
<td>9</td>
</tr>
<tr>
<td>Tomskaya oblast</td>
<td>25</td>
<td>5</td>
<td>6</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Nizhegorodskaya</td>
<td>38</td>
<td>7</td>
<td>11</td>
<td>14</td>
<td>3</td>
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<tr>
<td>oblast</td>
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<tr>
<td>Moskovskaya</td>
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ITP – TECHNOLOGY POTENTIAL INDEX; 
IEA – EXPORT ACTIVITY INDEX; 
IA – INNOVATIVE ACTIVITY INDEX; 
IAQ – INNOVATIVE POLICY QUALITY INDEX; 
ISEC – SOCIAL ECONOMIC CONDITIONS INDEX

Analysis of the data presented in Table 2 showed that among the leaders are Moscow (1st place) and St. Petersburg (2nd place).

Another method for assessing the effectiveness of innovative development is the method developed by the Association of Innovative Regions of Russia and the National Research University "Higher School of Economics".

This approach is based on multifactor models, which include a large number of heterogeneous indicators. It makes sense to use such methods when it is necessary to give a generalized assessment of innovativeness of an economic agent. Then the results obtained, due to the specificity of input data, will cover a greater number of parameters and, accordingly, give a more correct idea of the general dynamics of efficiency of innovative development of the region.

3 Results

A comparative analysis of the level of innovative development of the regions showed that higher indicators were recorded in the regions with a high percentage of clustered enterprises [10].

Figure 2 shows the data on the quantitative indicators of "isolated" innovative enterprises and indicators of innovative activity of clustered enterprises.
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Figure 2 shows the data on the quantitative indicators of "isolated" innovative enterprises and indicators of innovative activity of clustered enterprises.

The analysis of the data presented in Figure 2 showed that the indicators of innovation activity of clustered enterprises are significantly higher than those of "isolated" enterprises.

The advantages of combining isolated enterprises into clusters are presented below [10]:
- stability and predictability of cash flows will increase;
- sales effectiveness will increase;
- the cost of organizing the business is reduced due to lower transaction costs, building relationships between internal and external participants of the enterprise, a package approach to the design and signing of contracts, negotiations and information, search for importers;
- there is a positive dynamics in the development of enterprises of one cluster in the field of innovation. This is due to the fact that a large number of experienced and creative employees are concentrated in one cluster. Thus, all the accumulated knowledge, experience and skills of these people are stored in a single cluster, which provokes participants to generate unique ideas and develop new innovative projects. All of this together significantly accelerates all the innovative processes that exist in the cluster;
- the relations and connections between the participants within the cluster are actively improved, which positively influences the business processes: it helps to concentrate efforts more productively and to adjust to the unstable conditions of the external environment, becoming more flexible [11]. In this case, the final product must go through all the business processes of a particular cluster. At each of these stages the product increases its value. This method of production is called "value chain".
- it becomes easier to identify technological trends in innovation in a timely manner, which allows planning and forecasting of future developments;

Note that clustered enterprises are located in one sector, while clusters, at the same time, can conduct activities outside of this area.

At the same time, the goals of cluster strategies are different for states at different levels of economic development (see Fig. 3).
4 Discussions

Thus, increase of efficiency of resources use in the process of innovative development can be considered as actual and perspective point of growth for many regions of the Russian Federation today.

At the moment there is a large variety of methods, which allow assessing the effectiveness of innovative development of economic entities of various levels.

The basis of the proposed by the authors methodology for assessing the level of innovation development of the regions is the principle of correlation of resources and results by dividing all the calculated indicators into two groups of main factors: resource and result coefficients accordingly. The group of resource coefficients of the methodology is represented by two indicators [13]:

1) the coefficient of localization of companies carrying out scientific research work in the region:

$$K_c = \frac{D_{creg}}{D_{crf}},$$  \hspace{1cm} \text{where} \hspace{1cm} (1)

$D_{creg}$ – the share of companies engaged in research and development in the region, from the total number of companies in the region;

$D_{crf}$ – the share of companies engaged in scientific research in the region, from the total number of companies in Russia;

1) the coefficient of localization of personnel carrying out activities within the framework of research work:
Goals of cluster strategies are different for states at different levels of economic development, share of enterprises that have implemented the goals, %.

Figure 3 clearly shows the main goal of developed and developing countries is to increase value added. And for countries with economies in transition another goal is characteristic - to support the vectors of innovative development [12].

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The group of resource coefficients of the methodology is represented by two indicators:

1) the coefficient of localization of companies carrying out scientific research work in the region:

\[ K_p = \frac{D_{preg}}{D_{crf}}, \text{where} \]

\[ D_{preg} \] – the share of companies engaged in research and development in the region, from the total number of companies in the region;

\[ D_{crf} \] – the share of companies engaged in scientific research in the region, from the total number of companies in Russia.

1) the coefficient of localization of personnel carrying out activities within the framework of research work:

\[ K_p = \frac{D_{preg}}{D_{crf}}, \text{where} \]

\[ D_{preg} \] – the share of personnel carrying out activities within the framework of research work, from the total average number of personnel in the region;

\[ D_{crf} \] – the share of personnel engaged in R&D activities in the total average number of personnel in Russia.

The group of resultant coefficients of the methodology is also represented by two indicators:

1) the localization rate of companies actively implementing innovations:

\[ K_{ia} = \frac{D_{iareg}}{D_{iarf}}, \text{where} \]

\[ D_{iareg} \] – share of companies actively implementing innovations from the total number of companies in the region;

\[ D_{iarf} \] – share of companies actively implementing innovations from the total number of companies in Russia.

The methodology assumes that after the calculation of the main 4 coefficients has been performed, it is necessary to correlate the average localization coefficients by results and resources:

\[ E_{ir} = \frac{K_{result}}{K_{resource}}, \text{where} \]

\[ K_{result} \] – the average value of the coefficients of the group of performance indicators;

\[ K_{resource} \] – the average value of the coefficients of the group of resource indicators.

According to the results of the evaluation, it is required to compare the resource and performance coefficients, after which an integral indicator of the effectiveness of innovative development of the region will be obtained.

5 Conclusion

The assessment of innovative development of Russian regions, carried out by the authors within the framework of the proposed methodology (see formulas 1...4) showed that despite the small amount of resources, which the Lipetsk, Bryansk and Tula regions possess, for example, these regions manage to achieve significant results in terms of innovative development. Such situation, from the point of view of economy, is the most favorable.

On the other hand, there were identified regions, which, possessing a large number of conditions conducive to development, could not achieve high results in their own innovative development. Among such regions we can single out Tambov, Tver and Kaluga regions.

The best cumulative results, as the analysis showed, were achieved in Ryazan, Kostroma, Belgorod and Bryansk regions. The Voronezh, Tambov and Moscow regions achieved a significant increase in efficiency with a small absolute value.

The evaluation methodology presented by the author above can be called special. It allows you to consider the specific ratio of innovative resources used in the region and the results of its innovative activity. It makes it possible to draw a conclusion about the efficiency of use by the subject of those means which it really possesses. Moreover, serious distinctions in the
received results with other methods allow asserting that the developed model is really necessary in use.

So, Moscow, which is the most effectively developing region of the Central Federal District in terms of implementation of innovations, according to the results of the author's study, takes only 10th place in the overall ranking.

It can be explained by the fact that the structure of innovative resources and results of activity in Moscow has been settled for some time and does not show any significant dynamics, because a lot of money has been invested in the development of its innovative potential [14].

At the same time, the Kostroma region showed the best results according to the authors of the study, which can be explained as follows: while maintaining the same level of available innovative resources the region managed to create on average more innovations in 2020 compared to 2016.

The presented data show that there is a rather low level of internal expenditures on research and development, the only exception being the city of St. Petersburg, which is a modern center of innovation. St. Petersburg, which is a modern center of innovative development in Russia. It should also be noted that quite a large volume of financial resources allocated for development of innovation potential is formed in the regions where manufacturing industries are more developed.

Practice shows that innovations in the transport sector affect the dynamics of income growth of the regional economy due to the reduction of costs of the transport and logistics system, increase in the speed and volume of passenger and freight traffic, growth of investment attractiveness of the region, diffusion of innovation and growth of labor productivity. The development of green innovative technologies and their introduction into the processes of regional transport infrastructure functioning leads to the growth of recreational potential and stabilization of the ecological balance of the territory [15].

On the other hand, the increase in GRP leads to an increase in investment in the development of transport infrastructure and research in the field of finding new approaches to the operation and energy supply of regional transport systems. At the same time, railway transport does not lose its competitiveness among other types of transport due to significant volumes of transported passengers and freight with differentiated weather factors, optimized cost price and high prospects of innovative changes within the development of scientific and technological progress in the digital economy.

References
2. N.D. Kondratiev, The main problems of economic statics and dynamics (Nauka, M., 1991)
3. N.D. Kondratiev, Problems of economic dynamics (Nauka, Moscow, 1989)
4. S. Glazyev, A leap into the future. Russia in new technological and world economic structures (Book World, M., 2018)
5. S.Yu. Glazyev, Theory of long-term technical and economic development (VlaDar, Moscow, 1993)


