# INNOVATIVE DEVELOPMENT

UDC 332.05+330.341.1



## Comparative assessment methodology of the region`s scientific and technical potential*

*The article is devoted to some methodological questions on the research of the region's scientific and technical potential. It contains the general characteristic of existing domestic techniques used to evaluate the potential of the science and technology sphere and foreign techniques adapted to the Russian conditions. By the results of their analysis the authors suggest their own comparative evaluation technique that consists in calculation of the integral index– "the region scientific and technical potential index" reflecting both the efficiency and the scale of potential use in the region's territory.*

*Region, scientific and technical potential, comparative evaluation, technique.*

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The transfer of the region to the innovation way of development is impossible without the widespread introduction of advanced achievements of science, engineering and high technology into all spheres of human activity[1]. This circumstance objectively proposes an

[1] The transfer to the innovation way of development as the aim of policy of Russia and its regions in the scientific and technical sphere has been determined in "Conception of long-term social and economic development of the Russian Federation for the period until 2020": approved by the RF Government decree as of 17.11.2008 № 1662-d; in Guidelines for the RF Government action for the period until 2012: approved by the RF Government decree as of 17.11.2008 № 1663-d; in "Framework for the RF policy in the field of science and technologies development for the period until 2010 and in prospect": approved by the President of Russia as of 30.03.2002 № Pr-57.

* The research is done with the support of Russian human scientific fund (grant №09-02-00343v/I).).

availability of powerful scientific and technical potential (STPt) developing dynamically[2]. The starting point for the detailed study and further design of possible areas of its development and efficient use is an evaluation, i.e. determination of actual state of object to desired state or another object [12].

In the last two decades a considerable quantity of both the techniques adapted to the Russian conditions [18, 20, 21] and our own research techniques concerning scientific and technical potential of area (region, country in whole) appeared in the science of our country. Among such techniques are:

- technique of integral estimation of the country's scientific and technical potential (Japan);
- technique of integrated assessment of the country's scientific and technical potential (USA);
- technique of calculation of knowledge index (The World Bank);
- technique of calculation of total innovation index (Netherlands);
- technique of structural analysis of the territory's innovation activity (S.V.Kortov);
- technique of regression analysis of the territory's innovation activity (T.A.Shtertzer);
- technique of factorial analysis of the region's innovation potential (E.P.Amosenok, V.A.Bazhanov);
- technique of region clustering and innovation system development indices (A.E.Varshavski);
- technique of calculation of region's innovation ability index (Independent Institute of Social Policy of the RF);
- technique of region rating system depending on their innovation development level (A.B.Gusev).

Here we consider these techniques in details pointing out some positive and negative aspects of each of them within the framework of the stated below criteria [7, 13]: a) accessibility and impartiality of basic data; b) simplicity of technique and calculation; c) obviousness of result presentation; d) opportunity of evaluation from the positions of content (consideration of both the available resources in the science and technology sphere and the results of their practical use), functioning (research of both the usage efficiency and the scale of potential realization) and development (study of both the components of the science and technology sphere and educational and information-communication medium – the most important elements basing for forming and functioning of the potential in the territory under review); d) applicability to the research of region potential.

*Technique of integral estimation of the country scientific and technical potential* [1, 17] was suggested by the Government of Japan in "White Book". It uses eight indicators; by the authors' opinion as a unit they define the resource possibilities and the results of use of scientific and technical potential:

- numbers of scientists and engineers engaged in the sphere of scientific and technical development;
- national science expenditures;
- quantity of patents registered in the country;
- quantity of patents registered abroad;
- volume of technology trade (in value terms);
- volume of science-consuming product export;
- volume of added value cost in processing industry;
- volume of technology export.

The sum is estimated in regard with every indicator, the sum is taken as 100 and the share of indicator of every country in this sum is calculated. After calculation the results are represented as octactinal stars where their rays make the obtained scores in some scale and the angles between the rays amount to 1/8 of

[2] By *scientific and technical potential* we mean both the resource pool (human resources, institutional resources, material and technical resources, information resources and financial resources) and the results of scientific and technical activity which are interconnected and interacting with the external environment in some certain organizational and administrative conditions to solve the problems of current and prospective development of the territory, to raise its competitive capacity and to ensure the strong economic growth.

the circle. When connecting the ends of rays we have an irregular octagon which is regarded as integral characteristic of the country scientific and technical potential. The area of this figure shows the so-called “total power” of STPt and the ratio of areas of different countries makes it clear how many number of times one potential is “more powerful” than another. The form of octagon defines a contribution of some components to total index and it helps to reveal some specific character of the national scientific and technical potential.

The advantages of this technique are: a) flexibility – the number and the content of those that take part in the comparison of indices can be changed in accordance with the special objectives of research; b) simplicity of calculation – it is enough to use any common calculator to do calculations; and obviousness of results represented as polygons; c) accessibility of basic data which can be found in regular state statistics (while the use of this technique at the regional level is restricted by the lack of information on a number of indices). However the simplicity and accessibility within the scope of the technique are achieved owing to rather simplified approach to the task solution: neither the weight of some certain indices nor their interrelations are taken into account. Besides the sector of scientific brainpower training is left out of account, as well as the matters of maintenance supplies and information support of research and development (R/D). So the examined technique permitting to compare the STP of countries is a simple and logical step proceeding with the data of statistical books of reference and digests.

*Technique of integrated assessment of the country scientific and technical potential* [1] was created in Georgia Technological Institute (Atlanta) under the aegis of National Science Foundation (USA). To estimate STP the authors suggest to research four complex indicators: national focus (НО), socioeconomic infrastructure (СИ), technological infrastructure (ТИ) and productivity (П). The formulae for its estimation are the following:

$$НО = М_1 + (М_2 + М_3)/2 + М_4 + ФР, \quad (1)$$

where $М_1$ – expert assessment of national strategy of science and technology development;

$М_2$ and $М_3$ – expert assessments of social factors which are favourable to production processes development;

$М_4$ – expert assessment of business activity;

ФР – risk factor connecting with the investments in economy of the given country.

$$СИ = М_5 + М_{10} + ППУ, \quad (2)$$

where $М_5$ – expert assessment of capital mobility;

$М_{10}$ – expert assessment of country’s efforts aimed at the attraction of foreign capital;

ППУ – percentage of the students entering the educational institutions of the second and the third degree.

$$ТИ = (М_7 + М_8)/2 + М_9 + М_{11} + ОЗЭ + УИ, \quad (3)$$

where $М_7$ and $М_8$ – indices of national academic science activity (patenting, sale of licenses etc.);

$М_9$ – expert assessment of connection of national science with country industry;

$М_{11}$ – expert assessment of national economy capability to make the best use of technical knowledge;

ОЗЭ – annual volume of procurement of electronic information-processing devices;

УИ – number of scientists and engineers engaged in the sphere of research and development.

$$П = М_6 + М_{12} + М_{13} + ПЭТ, \quad (4)$$

where $М_6$ – expert assessment of availability and quality of skilled manpower;

$М_{12}$ – expert assessment of possibilities of national providers who supply the production of science-consuming products with parts and assemblies;

$М_{13}$ – expert assessment of production management quality;

ПЭТ – annual volume of electronic engineering production in the country.

First of all to calculate the complex indicators every index is converted to the scale 0 – 100 (the country having the maximum index is taken for 100), then one adds up the received values (their weights are considered equal) and strikes the average which is taken for indicator value. Then the countries are ranked by these values and are compared in every one of the indicators.

The principal feature of the technique under consideration is its complexity that is reached by using both the statistical data and the expert inquiry results when calculating. In spite of the simplicity of calculations, the obviousness of result presentation and the opportunity of comparative evaluation of STPt of the objects from the positions of content and functioning there are some disadvantages in this technique: a) using the experts' subjective evaluations and the statistical data which are not published in statistic widely (especially from the regional sectional view); b) using the long and labor-consuming procedure and consequently the high-cost one (questionnaire construction, questioning, questionnaire processing) to get and analyze the experts' opinions. The complication of evaluation process is justified only if the information value of result and its importance increase in accordance with the increase in the costs of the result achievement. In our opinion this condition isn't fulfilled in the case at issue.

Now we turn to the technique by the World Bank [14, 15], where the role of integral index is played by *the knowledge index (KI*) representing itself the average out of three components of its indices: a) innovation system; b) education and human potential; c) information infrastructure. These indices are calculated as arithmetic average of normalized data by the indicators taken from the official regular statistics in the sections "Scientific research and

Table 1. Indicators of the knowledge index components

| Index component | Indicator |
|---|---|
| 1. Innovation system | Number of organizations carrying out the research and development<br>Number of active innovation organizations of industry and services, total<br>Number of active innovation organizations of industry and services dealing with job-related design and development, % out of the total number of respective organizations<br>Internal current costs for basic research, % to the sum total of internal current costs for research and development<br>Internal current costs for equipment, % to the sum total of internal current costs for research and development<br>Specific weight of technological innovation costs in the volume of shipments of active innovation organizations, %<br>Number of granted patents, patent(s) per 10 thousand people<br>Percentage of persons having graduated from post-graduate course and having defended their theses, % to the total number of post-graduate students<br>Percentage of persons having worked for doctor's degree and having defended their theses, % to the total number of persons having worked for doctor's degree |
| 2. Education and human potential | Literacy of adult population, % to the number of population aged 15 and more<br>Number of day comprehensive establishments<br>Number of institutes of higher education<br>Number of higher education students, students per 10 thousand population<br>Number of graduates (having taken degree), % to the total number of employable population<br>Investments in fixed capital of the education sector, % out of the total volume of investments |
| 3. Information infrastructure | Number of organizations having used ICT<br>Number of personal computers, computers per 100 workers<br>Number of organizations having web-sites<br>Number of organizations having used special software – total<br>Costs for software purchasing, % out of the total volume of costs for information and communication technology<br>Number of organizations having used special software, % out of the total number of respective organizations<br>Availability of residential telephones in the common-user network, number of telephone sets per 1 thousand urban residents |
| Sources: Ferova I.S. Index components of "knowledge economy" // ECO. – 2006. – №12. – Pp. 60-63; Chugunov A.V. Indicator system and monitoring of information society and knowledge economy development // Bulletin of international organizations: education, science, new economy. – 2006. – №7. | |

innovations", "Education", "Information and communication technology" *(tab. 1)*.

The data normalization results from the following formula [5]:

$$ND = 10 \cdot \frac{N^w}{N^c},$$

where *ND* – normalized data (take the values from 0 up to 10, and 10 is the maximum value that is appropriate to the object with the highest indicator);

$N^w$ – number of the objects with the worse indicators;

$N^c$ – common number of the objects under consideration.

Then on the basis of the arithmetic average of indices of the innovation system, the education and human potential, the information infrastructure one calculates the total knowledge index for every object in the group under consideration. By ranking of the received knowledge one draws up a rating, and at that the object with the maximum value of index comes to the fore. The technique is easy-to-operate, it is notable for its accessibility of basic data and its obviousness of the received results, but the technique can't evaluate both the possibilities of the territory scientific and technological development and its realization efficiency in full.

*Technique of calculation of total innovation index* [10] was suggested by Maastricht Institute of Economic Research in the field of Innovation and Technology (MERIT, Netherlands) to evaluate and compare the innovation achievements of the countries – the members of the European Community [3]. Depending on the object of research the scientific officers of the Institute worked out the World, Region and Sector innovation indices. These indices are integral indicators (they describe situation in such directions as the conditions for innovations, the investments in knowledge, the innovation and business, the innovation use and the intellectual property) including the whole set of standardized indicators. Below you can find a set of indicators necessary to determine the Region total innovation index [19]:

- people who have gained a higher qualification (% of population aged 25 - 64);
- participation in continuing education (% of population aged 25 - 64);
- employment concerned with the middle and high level technologies production (% of total manpower);
- employment in the sphere of high-technology services ((% of total manpower);
- public expenses of research and development (% of GDP);
- incoming of the high-technology patent applications to European Patent Office (per million people);
- incoming of the patent applications to European Patent Office (per million people);
- share of innovation enterprises (% of all industrial enterprises);
- share of innovation enterprises (% of all service enterprises);
- innovation costs (% of all industry turnover);
- innovation costs (% of all service turnover);
- sales of products which are new for the enterprise but not new for the market (% of all industry turnover).

The calculation of the indicator ( $x_i^r$ ) values is done according to the following formula [10]:

$$x_i^r = \frac{x_i - \min(x_i)}{\max(x_i) - \min(x_i)}, \qquad (6)$$

where $x_i$ – transmuted score of i indicator;

$\min(x_i)$ – the least transmuted score of i indicator;

$\max(x_i)$ – the most transmuted score of I indicator.

As follows from the formula (6), all standardized indicators take the values from 0 up to 1 (0, if (xi= min(xi); 1, if xi = max(xi)). The indices are defined as average values of the calculated indicators with using of equal weighting. The nearer the index is to 1, the higher the level of innovation development of the object under review.

[3] The index is published every year since 2001 in the review (European Innovation Scoreboard) [Electronic resource]. – Access mode: http://www.trendchard.org/).

The advantages of this technique are simplicity of calculations, obviousness of the received results and its applicability to the region STP evaluation both in comparison with other subjects and depending on the economic activity categories. At the same time the use of this technique is restricted by some factors: a) lack of part of indicators published in the official statistic digests on the regional level; b) it's impossible to account the scope of use and the efficiency of potential realization in the region territory simultaneously.

S.V.Kortov worked out the technique of structural analysis of area innovation activity [2, 10] in the branch sectional view, and it was supplemented with the strategy indicators in the sphere of research and innovative activity. When relying on the concept of technological setups one can state that in the branches belonging to the different setups the degree of linkage between technology and science is different. This circumstance predetermined the need for calculating some special indicators:

1. Index of science consumption of the branch (ISCB) – ration of the total costs for science and purchase of technologies within the scope of international technological exchange (by import) to the volume of industrial capacity of branch in the given territory.
2. Coefficient of technological independence of the branch (CTIB) – ration of the internal costs for research and development in the branch to the imported technologies.
3. Index of technological exchange (ITE) – income-to-payment ration with the trade turnover of technologies and research-and-development results.

Having calculated the values of these indicators one can have the opportunity to determine the degree of science consumption and technological independence of one branch or another in the territory under consideration and to compare them with the benchmarks requisite for strong growth[4]. Ranking the indicators of ISCB, CTIB and ITE by size one performs the economy's "branch profile" which defines the level of innovation activity and the degree of scientific and technical potential development of the territory.

T.A. Shtertzer suggested the way of determination of the territory innovation activity similar to the working described above. Studying the factors having effect on the innovation activity in the regions the author uses the technique of regression analysis [2; 16]. As a result the statistical data of the objects under review are used to build a number of regression equations describing for example the correlation between the number of filed applications for inventions and the principal factors influencing the innovation activity (expansion of demand, size of human capital, amounts of financing of scientific research and development, investment activity etc.). By the results of calculation and analysis one reveals the factors having some positive and negative influence over the level of territory innovation activity.

Using their techniques to determine the type of innovation development of the territory and the level of its receptivity to innovations S.V. Kortov and T.A.Shtertzer tried to build one strategy or another and to forecast the further directions of development.

E.P. Amosenok and V.A. Bazhanov worked our the *technique of factorial analysis of region innovation potential* [2] on the basis of principal components method. As is known when analyzing the cause-and-effect relations one can discover some hidden general characteristics of higher order out of the set of elementary characters. So, the state statistical data from the section "Scientific research and innovations" were used as a combination of basic indicators. Following the data analysis the authors brought out six principal components (factors) that were used by them as integral indicators or evaluations of the single parts of the region innovation potential. The sets of indicators by factors are divided up into the following groups *(tab. 2)*.

[4] The boundary values of indicators are determined on the basis of papers and published works by the scientists of the key sections of the Russian Academy of Sciences (A.I.Tatarkin, A.E.Varshavskii, V.L.Makarov, D.S.Lvov, Y.V.Gulyaev and others).

Table 2. Integral indicators of the region innovation potential

| Factor | Indicator |
|---|---|
| 1. Research potential of population | Number of organizations doing research and development<br>Number of organizations engaged in training of post-graduate students<br>Number of post-graduate students<br>Number of persons admitted to post-graduate course<br>Number of persons having graduated from post-graduate course<br>Number of persons having graduated from post-graduate course and having defended their theses<br>Number of doctoral students<br>Number of persons admitted to doctoral-level program<br>Number of persons having worked for doctor's degree<br>Number of persons having worked for doctor's degree and having defended their theses<br>Personnel engaged in research and development, total<br>Researchers graduated with academic degrees, total<br>Researchers graduated with doctor's degree<br>Researchers graduated with candidate's degree<br>Internal current costs for research and development, total<br>Internal current costs for applied research |
| 2. Expenditure capacity of gross regional product (GRP) by research works | Internal costs for research and development, total<br>Internal current costs for research and development, total<br>Internal current costs for applied research<br>Costs for technological innovations<br>Volume of innovation production having received some great technological changes or newly-introduced<br>Volume of innovation production having been updated |
| 3. «Science consumption» of GRP by doctorates | Number of doctoral students<br>Number of persons admitted to doctoral-level program<br>Number of persons having finished their work for doctor's degree<br>Number of persons having worked for doctor's degree and having defended their theses |
| 4. «Science consumption» of GRP by researchers graduated with academic degrees | Researchers graduated with academic degrees, total<br>Researchers graduated with doctor's degree<br>Researchers graduated with candidate's degree |
| 5. Inventive potential of economically active population | Volume of innovation production having received some great technological changes or newly-introduced |
| 6. Level of innovation activity of organizations | Specific weight of technological innovation costs in the volume of shipments of active innovation organizations, per 1 rouble GRP<br>Specific weight of technological innovation costs in the volume of shipments of active innovation organizations, per head of economically active population |

Source: Amosenok E.P. Integral evaluation of innovation potential of Russia's regions // Region: Economy and sociology. – 2006. – №2. – Pp.138-140.

The regions under evaluation are ranked in decreasing sequence of the total values of principal components, and then their average rank is determined. The factors are interpreted by the indicators having the most significant load (more than 0,7). It gives the opportunity to draw the objective quantitative comparison between the components of innovation potential of the regions, and it is more effective concerning the use of primary statistical data.

The examined techniques by S.V.Kortov, T.A. Shtertzer, E.P.Amosenok and V.A. Bazhanov are difficult-to-calculate, they involve some heavy labor expenditures and demand much of the set of basic statistical information (it is especially difficult from the regional sectional view). Another more important disadvantage is that these techniques describe the potential of innovation development of the territory rather incompletely without regard for the peculiarities of its functioning and development.

To evaluate the scientific and technical potential A.E.Varshavski suggested *clustering of the regions* [6, 21] on the basis of six indications:

- correlation between the wage levels in the branch "Science and science service" and in the region's economy in whole;
- correlation between the internal costs for research and development and for GRP;
- the share of export to the countries far abroad in GRP;
- the share of personnel engaged in research and development in the total number of persons engaged in economy;
- the number of granted patents and inventor's certificates per 1 mln. People;
- average per capita level of GRP.

To give quantitative evaluation of the science effectiveness and the degree of country's transition to the society based on knowledge the author chose three groups of key indicators of *innovation system* development [5] at the regional and national levels:

1. Indicators characterizing the innovation system input.
2. Indicators characterizing the innovation system output.
3. Internal indicators characterizing the external institutional environment with the scope of which is the innovation system *(tab. 3)*.

Then the objects under consideration (regions, countries) are compared and ranked by these indicators on determining their position in the group.

The advantage of this technique is conditioned by its simplicity, the accessibility of information and the opportunity to compare the indicators of science and technology functioning of the different objects. Besides the technique can give the rank evaluation of the development of innovation processes and find the most acute problems obstructing the research and innovation activation in the territory under review. However the problems connected with the simultaneous assessment of the scientific and technical potential scope and its efficiency remain unsolved here.

[5] The author means by innovation system a complex of entities interacting in the course of making and realization of innovation products (services) and conducting their innovation activity on the basis of proper normative legal sources within the framework of the government's existing policy.

*The technique of calculation of region's innovation ability index* [13] worked out by Independent Institute of Social Policy of the RF is of interest for our research too. Its basis is a set of five following factors illustrating the objects' capability to invent and their readiness to introduce the innovations in the economy:

- the number of personnel engaged in research and development, by % out of the total number of the persons engaged in economy;
- the number of higher school students, per 10 thousand people;
- the number of filed patents, per 1 thousand people engaged in economy;
- the costs of technological innovations, rouble/man;
- the Internet use level, %.

Within the framework of each factor the indicators are normalized by the formula of linear scaling (6), and then on the basis of their arithmetic average one determines the region's innovation ability index. In spite of the simple operating, basic data accessibility and obviousness of the received results this technique can't evaluate the capabilities of the territory's innovation development and their efficiency in full.

A.B. Gusev worked out *the technique of region rating system depending on their innovation development level* [3]. Its basis is two groups of factors. The first group – receptivity to innovations – is represented by such indicators of technological efficiency of the regional production as:

a) labor productivity – is estimated as ration of the subject's GRP to the average annual number of engaged in the regional economy;

b) capital productivity of production – is calculated as ration of the subject's GRP to the fixed capital value;

c) ecological compatibility of production is a result obtained by dividing the subject's GRP by the volume of harmful emission into the atmosphere from the stationary sources.

In the rating technique the indicators of the second group – innovation activity – are represented by such specific indicators as: a) costs of research and development per one employed

Table 3. Indicators of innovation system development

| Group of indicators | Indicator |
|---|---|
| 1. Indicators input | Costs of research and experimental development, by % to GRP<br>Expenses of research and experimental development to the gross accumulation of fixed capital, thousand roubles / million roubles<br>Costs of technological innovations to costs of research and experimental development, times<br>Costs of technological innovations to the number of people engaged in economy, roubles / persons<br>Personnel engaged in research and experimental development in the total number of persons engaged in economy, %<br>Number of persons graduated with doctor's degree and candidate's degree per 100 thousand employed population, persons<br>Number of post-graduate students in ratio to the personnel engaged in research and experimental development, %<br>Number of post-graduate students in ratio to the number of persons graduated with doctor's degree and candidate's degree, times<br>Number of persons having graduated from post-graduate course to the number of persons engaged in research and experimental development, times<br>Number of post-graduate students having defended their theses to the number of persons engaged in research and experimental development, times |
| 2. Internal indicators | Number of personal computers and provision of the organizations with them, %<br>being included in the local computer networks<br>having access to the global information networks<br>including the Internet<br>Personnel engaged in research and experimental development, per a organization, persons<br>Share of researchers to the personnel engaged in research and experimental development, %<br>Share of persons graduated with doctor’s degree and candidate’s degree to the total number of researchers, %<br>Share of persons graduated with doctor’s degree and candidate’s degree in the personnel engaged in research and experimental development, %<br>Internal costs per a researcher, thousand roubles per man<br>Internal costs per a person engaged in research and experimental development, thousand roubles per man<br>Remuneration of labor of one person engaged in research and experimental development, thousand roubles / man<br>Share of basic research in costs of research and experimental development, %<br>Share of applied research in costs of research and experimental development, % |
| 3. Indicators output | Specific weight of technological innovation costs in the volume of shipments of active innovation organizations, %<br>Filing of patent applications and issue of protection documents to the costs of research and experimental development, units per milliard roubles<br>Number of the filed: a) applications for inventions; б) applications for useful models and patents for inventions<br>Number of the granted: a) patents for inventions; б) certificates for useful models and patents for inventions<br>Filing of patent applications and issue of protection documents to the technological innovation costs, units per milliard roubles<br>Number of the filed: a) applications for inventions; б) applications for useful models and patents for inventions<br>Number of the granted: a) patents for inventions; б) certificates for useful models and patents for inventions |
| Source: Varshavskii A.E. The problems and indicators of innovation system development // Innovative way of development for new Russia / Editor-in-chief V.P.Goreglyad. – M.: Nauka, 2005. – Pp. 201-204. | |

worker; b) costs of technological innovations per one employed worker; c) innovation production output per capita in the region.

Each of the indicators in both groups are counted up with regard to the leader region whose indicator value is taken as 100. Then one carries out some mathematical transformations which convert the relative values of indicators into the total rating (on the basis of the arithmetical average calculation formula), and the regions’ innovation development rating is formed.

The principal feature of this technique is that the rating indicators reflect the innovation activity efficiency in point of process (innovation activity) and in point of its result (receptivity to innovations). The technique is notable for its simplicity, accessibility of the basic information and obviousness of the received results, but it doesn’t properly meet the assessment criteria from the position of functioning (efficiency and realization scope).

The advantages and disadvantages of the STPt research techniques having been analyzed, it is clear that none of these techniques agrees with the claimed criteria completely *(tab. 4)*.

Taking account of the above we worked out our own comparative evaluation **technique to determine the region'**s scientific and technical potential. It is based on the integral indicator calculation – "the region's scientific and technical potential index".

When creating the technique we used the tools existing in this direction and some positive experience (based on the analysis of the technique examined above) and the following principles [9]:

- getting of the evaluation of potential as directly non-measurable magnitude through the indicators system taken from the official statistical report;
- the necessity and sufficiency of the chosen indicators system to show the potential condition;
- representing of the graphic- and-analytical results of the potential evaluation.

Our technique is based on determining of the region's scientific and technical potential index ($I_{НТПm}$) which is arithmetic average of the indices ($I_k$) composing modules (k = 1, 2, 3, ..., K). According to the broad interpretation they describe some potential's characteristics (science sector, education sector, service lines sector and others):

$$I_{НТПm} = \frac{1}{K} \cdot \sum_{k=1}^{K} I_k. \qquad (7)$$

Each module includes some certain set of indicators defining the region potential as resource pool and research results (from the positions of content). Moreover according to the complex expression of potential from the positions of functioning each indicator must be considered from both sides: a) the first side is indicative of efficiency of available resources and results of the science and technology area; b) the second side defines the scope of potential realization in the region territory *(fig. 1)*. Such approach to forming of the indicators system makes it possible to evaluate both the scientific and technical potential and its compliance with the needs of region's social and economic sphere.

To compare some different indicators (i.e. to bring to the identical dimension) they are represented as normalized data with the help of correlation of actual values *($З_m$)* with the best ones in the sample *($З_m^{max}$)* by the following formula:

$$НД_m = 10 \cdot \frac{З_m}{З_m^{max}}. \qquad (8)$$

So, the indicators of evaluation of the region's scientific and technical potential in the modules can be presented in the following way:

$$НП_m = \frac{НД_m^x + НД_m^y}{Z}, \qquad (9)$$

where $НП_m$ – normalized indicator in the module;

$НД_m^x$ – normalized component defining the scientific and technical potential from the positions of its efficiency;

$НД_m^y$ – normalized component defining the scientific and technical potential from the positions of the scope of its use;

Z – number of components of the indicator (Z = 1 or 2).

The indices of the individual modules of the STPt are calculated as arithmetic average of the normalized indicators values composing one or another section:

$$I_k = \frac{1}{M} \cdot \sum_{m=1}^{M} НП_m, \qquad (10)$$

where m – number of indicators in the module (m = 1, 2, 3, ..., M).

In the expanded form the formula to calculate the region's scientific and technical potential index can be expressed in the following way:

$$I_{НТПm} = \frac{1}{K} \cdot \sum_{k=1}^{K} \left[ \frac{\sum_{m=1}^{M} \left( \frac{НД_m^x + НД_m^y}{Z} \right)}{M} \right] \qquad (11)$$

Table 4. Characteristics of the territory's scientific and technical potential research techniques

| Technique | Criterion | | | | | | |
|---|---|---|---|---|---|---|---|
| | Accessibility and impartiality of basic data | Simplicity of technique and calculations | Obviousness of result presentation | Opportunity to evaluate the potential from the positions of | | | Applicability to the research of the region's potential |
| | | | | content | functioning | development | |
| Integral estimation of the country's scientific and technical potential (Japan) | ± | + | + | + | – | – | ± |
| Integrated assessment of the country's scientific and technical potential (USA) | ± | + | ± | + | ± | + | ± |
| Calculation of knowledge index (The World Bank) | + | + | + | + | – | + | + |
| Calculation of total innovation index (Netherlands) | ± | + | + | + | – | + | + |
| Structural analysis of the territory's innovation activity (S.V.Kortov) | ± | + | + | + | ± | – | ± |
| Regression analysis of the territory's innovation activity (T.A. Shtertzer) | ± | – | ± | + | ± | – | + |
| Factorial analysis of the region's innovation potential (E.P. Amosenok, V.A. Bazhanov) | + | ± | ± | + | – | ± | + |
| Region clustering and innovation system development indices (A.E. Varshavski) | + | + | + | + | – | + | + |
| Calculation of the region's innovation ability index (Independent Institute of Social Policy of the RF) | + | + | + | + | – | + | + |
| Region rating system depending on their innovation development level (A.B. Gusev) | + | + | + | + | – | + | + |

*Symbols: «+» – the technique meets the criterion; «-» – the technique doesn't meet the criterion; «±» – the technique meets the criterion in part.

Figure 1. Characteristics of some indicator of region's scientific and technical potential

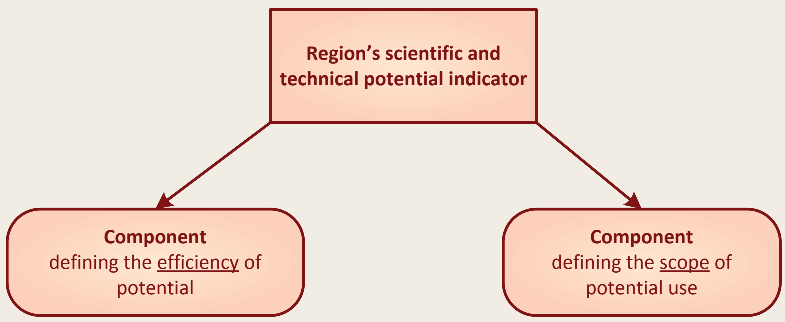
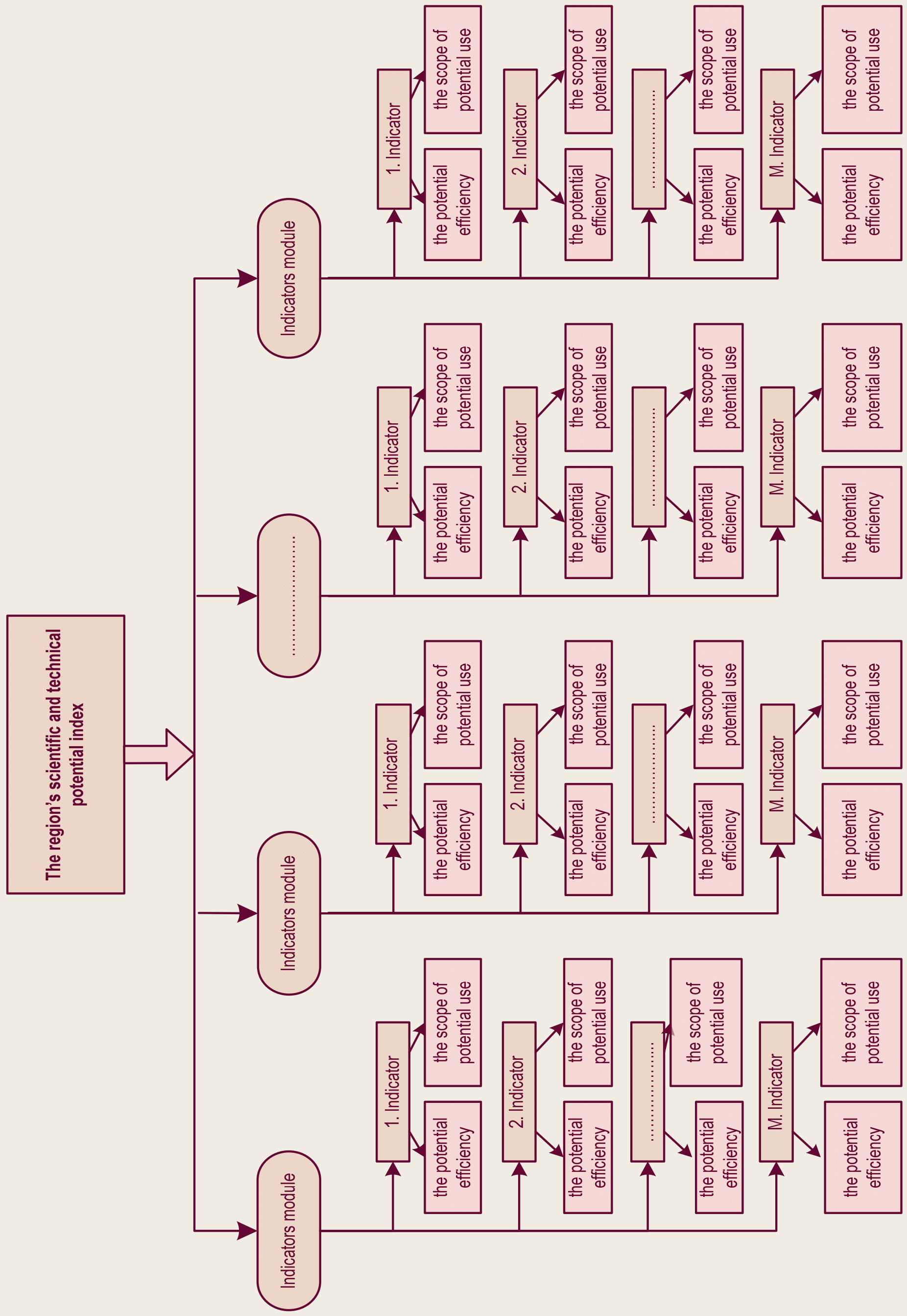
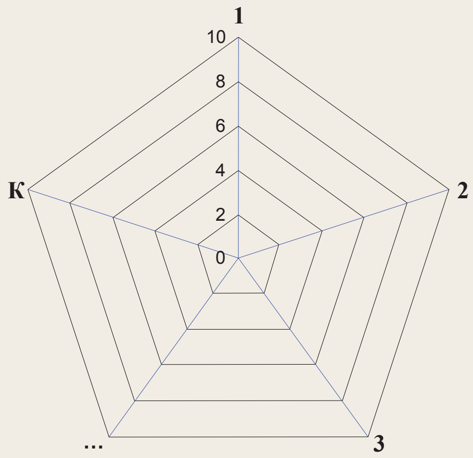


Figure 2. General scheme to estimate the region's scientific and technical potential




M – number of indicators in the block
K – number of blocks

Figure 3. Graphic representation of blocks indexes of the region's scientific-technical potential




Note. 1,2,3, ... K – blocks of indicators.

In *figure 2* you can see the general scheme to estimate the region's scientific and technical potential according to our technique:

To improve the obviousness of the obtained results one can make graphic representation of the region's STPt *(fig. 3)*. Each axis of polygon will be corresponded with the index of the individual indicators module and reflected its contribution to the total region's scientific and technical potential index.

The represented technique to evaluate the region's scientific and technical potential makes it possible:

• to analyze the state and the efficiency level of scientific and technical potential development of the single region in comparison with the other constituent territories;

• to estimate the resources which are the components of potential and the results of their use as well as the internal and external structural interrelations;

• to estimate the scope of scientific and technical potential realization in the territory under review and its contribution and capability to meet the needs of social and economic sphere as well;

• to define problems, to diagnose the causes (internal and external) of arising changes, to form the directions of development of the region's science and technology sphere;

• to group the territories according to the level of scientific and technical potential development etc.

The research results can be used in theoretical and applied studies in the field of territories' scientific and technical potential evaluation.

The approbation of the developed technique is planned to publish in the next article.

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