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IMPROVING THE SYSTEM OF INNOVATION ACCELERATION IN THE COUNTRY: METHODOLOGICAL ASPECT

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Abstract

Acceleration of innovation activities is the basis of both economic growth and social development at the present stage of the economic process development. In order to stimulate innovation activities one needs to study the methodology of developing the country's innovation rankings. A number of indicators and indices, published during certain periods, are used in the study that evaluates innovation activities. We believe that it is necessary to develop an approach, which can serve as an impulse to make decisions and rationally use available economic resources in order to motivate people for intellectual work, train scientific researchers and establish national innovation "laboratories". For the management of innovative activity an important role is played by the expansion of the circle and improving the quality of information, on the basis of which the corresponding solutions are accepted. It is necessary along with private indicators of innovation to use in the analysis and management some consolidated, integrated, synthetic and generalizing indicators. It should be noted that the development of various types of integrated indicators and their characteristics is an extremely difficult task.

***Key words*:** *innovative activity, economic processes, innovative rankings, virtual structure, innovative performances*

INTRODUCTION

Studies show that one should be guided by the leaders in all aspects of the innovation activity, but countries or regions can only occupy a leading position in a particular field of activity. Therefore, it is necessary to analyse and choose the best indices of all partners and competitors, and, based on the data received, create an absolute leader that can be called virtual.

Next, one should relate the cost structure in one's own country with the indices of the standard that has been developed. This is going to become an impulse to activate the innovation process and accelerate the innovation activity in the country.

MATERIALS AND METHODS

The methodology of scientific research is based on use of analytical and mathematical analysis tools.

In order to justify the approach nominated in the article were applied the dialectical method, system, functional, statistical and comparative analysis, as well as linear scaling and mathematical modelling.

RESULTS AND DISCUSSIONS

Let us consider innovation in the context of four real countries and one virtual standard. The organization system under the established conditions is aimed at implementing the following objectives:

-to compare the innovation performance of each of the four real countries with the performance of the virtual standard;

-to determine how the virtual structure manages to achieve the best results;

-to use the leading country's results to improve innovation activities of the four real structures.

We have selected *the USA, the EU, Japan and the Rest of the World* as the real countries that are involved in innovation activities. The selection of real structures is subjective.

The alternative choice may include all the countries, groups of the countries, regions, etc. The countries we have chosen – the USA, the EU, Japan and the Rest of the World – make up the central force of the comprehensive development for the whole humanity (if necessary, one may also choose Brazil, Russia, India and China in the studies

of this type. This is to be determined by a relevant scientific direction).

The research idea is based on the following factors: (a)Innovation activities, five blocks (driving forces of innovation); (b)Production of knowledge; (c)Innovation activities of the business sector; (d)Practical application of innovations; (e)Intellectual ability (Table 1).

Driving forces of innovation in the context of four real and one virtual structure are crucial for innovation activities inside block (1). Macro events (1) consist of five events: (1.1.) science and engineering graduates; (1.2.)the third-level education; (1.3.)the penetration rate of the broadband access to scientific and innovative information on the Internet; (1.4.)lifelong learning; (1.5.)youth education (Table 2).

Table 1. Innovation activity of the virtual structure in the context of five macro events

Macro events	USA	EU	Japan	The Rest of the world	Standard structure
	1	**2**	**3**	**4**	**5**
(1) Driving forces of innovation	A_{11}	A_{12}	A_{13}	A_{14}	A_{15}
(2) Production of knowledge	A_{21}	A_{22}	A_{23}	A_{24}	A_{25}
(3) Innovation activities of the business sector	A_{31}	A_{32}	A_{33}	A_{34}	A_{35}
(4) Practical application of innovations	A_{41}	A_{42}	A_{43}	A_{44}	A_{45}
(5) Intellectual ability	A_{51}	A_{52}	A_{53}	A_{54}	A_{55}

The source: developed by the author

Table 2. Innovation activities of real and virtual structures (1) in the context of five events

Events (1)	USA	EU	Japan	The Rest of the world	Standard structure
	1	**2**	**3**	**4**	**5**
(1.1) Science and engineering graduates	$A_{11}^{(1)}$	$A_{12}^{(1)}$	$A_{13}^{(1)}$	$A_{14}^{(1)}$	$A_{15}^{(1)}$
(1.2) The third-level education	$A_{21}^{(1)}$	$A_{22}^{(1)}$	$A_{23}^{(1)}$	$A_{24}^{(1)}$	$A_{25}^{(1)}$
(1.3)The penetration rate of the broadband access to innovative information on the Internet	$A_{31}^{(1)}$	$A_{32}^{(1)}$	$A_{33}^{(1)}$	$A_{34}^{(1)}$	$A_{35}^{(1)}$
(1.4) Lifelong education	$A_{41}^{(1)}$	$A_{42}^{(1)}$	$A_{43}^{(1)}$	$A_{44}^{(1)}$	$A_{45}^{(1)}$
(1.5) Youth education	$A_{51}^{(1)}$	$A_{52}^{(1)}$	$A_{53}^{(1)}$	$A_{54}^{(1)}$	$A_{55}^{(1)}$

The source: developed by the author

The virtual standard structure of Table 1 is characterized by the best performance:

$$A_{15} = max\{A_{11}, A_{12}, A_{13}, A_{14}\};$$
$$A_{25} = max\{A_{21}, A_{22}, A_{23}, A_{24}\};$$
$$A_{35} = max\{A_{31}, A_{32}, A_{33}, A_{34}\};$$
$$A_{45} = max\{A_{41}, A_{42}, A_{43}, A_{44}\};$$
$$A_{55} = max\{A_{51}, A_{52}, A_{53}, A_{54}\}.$$

Similarly, we determined the standard structure in Table 2.

$$A_{15}^{(1)} = max\left\{A_{11}^{(1)}, A_{12}^{(1)}, A_{13}^{(1)}, A_{14}^{(1)}\right\};$$
$$A_{25}^{(1)} = max\left\{A_{21}^{(1)}, A_{22}^{(1)}, A_{23}^{(1)}, A_{24}^{(1)}\right\};$$
$$A_{35}^{(1)} = max\left\{A_{31}^{(1)}, A_{32}^{(1)}, A_{33}^{(1)}, A_{34}^{(1)}\right\};$$
$$A_{45}^{(1)} = max\left\{A_{41}^{(1)}, A_{42}^{(1)}, A_{43}^{(1)}, A_{44}^{(1)}\right\};$$
$$A_{55}^{(1)} = max\left\{A_{51}^{(1)}, A_{52}^{(1)}, A_{53}^{(1)}, A_{54}^{(1)}\right\}.$$

Multiple activities for Macro events (2) include: (2.1.)public expenditures on research and development; (2.2.) expenditures of enterprises on research and development; (2.3.) the share of scientific works; (2.4.) the share of the companies, funded by the state.

The structure of innovation activities of Macro event (2) is presented in Table 3.

Table 3. Innovation activities of real and virtual structures (2) in the context of four events

Events (2)	USA	EU	Japan	The rest of the world	Standard structure
	1	2	3	4	5
(2.1) public expenditures on research and development	$A_{11}^{(2)}$	$A_{12}^{(2)}$	$A_{13}^{(2)}$	$A_{14}^{(2)}$	$A_{15}^{(2)}$
(2.2) expenditures of enterprises on research and development	$A_{21}^{(2)}$	$A_{22}^{(2)}$	$A_{23}^{(2)}$	$A_{24}^{(2)}$	$A_{25}^{(2)}$
(2.3) the share of scientific works	$A_{31}^{(2)}$	$A_{32}^{(2)}$	$A_{33}^{(2)}$	$A_{34}^{(2)}$	$A_{35}^{(2)}$
(2.4) the share of the companies, funded by the state.	$A_{41}^{(2)}$	$A_{42}^{(2)}$	$A_{43}^{(2)}$	$A_{44}^{(2)}$	$A_{45}^{(2)}$

The source: developed by the author

Where: $A_{i5} = \max_{1 \le i \le 4}\{A_{i5}\}, i = 1; 2; 3; 4$ is the standard structure, regarding which the performance level is defined for the USA, the EU, Japan and the Rest of the world.

Indices of the innovation development can be used, as they are an integral part of theoretical models, which describe the relationship

between the innovation activity, the economic growth and international competitiveness. [2] Therefore, it is necessary to consider the interdependence of macro events and related activities.

The composition and structure of macro events and events depends on the nature and special character of the innovation activity. In this study we apply the structure of innovation events, proposed by D. Perani and S. Sirilli [4]. Let us consider the parameters of the innovation activity, which are different in different countries, depending on the attitude to the development of the knowledge economy in the country.

Innovation activities of the business sector depend on the following factors: (3.1.) the number of small and medium-sized enterprises, engaged in innovation; (3.2.) cooperation of small and medium-sized enterprises with external partners; (3.3.) innovation expenditures; (3.4.) investments at early stages; (3.5.) the cost of information and communication technologies; (3.6.) small and medium-sized enterprises that have implemented organizational innovations.

The innovation activity structure of Macro events (3) is presented in Table 4.

Table 4. Innovation activities of real and virtual structures (3) in the context of five events

Events (3)	USA	EU	Japan	The Rest of the world	Standard structure
	1	2	3	4	5
(3.1) the number of small and medium-sized enterprises, engaged in innovation	$A_{11}^{(3)}$	$A_{12}^{(3)}$	$A_{13}^{(3)}$	$A_{14}^{(3)}$	$A_{15}^{(3)}$
(3.2) cooperation of small and medium-sized enterprises with external partners	$A_{21}^{(3)}$	$A_{22}^{(3)}$	$A_{23}^{(3)}$	$A_{24}^{(3)}$	$A_{25}^{(3)}$
(3.3) innovation expenditures	$A_{31}^{(3)}$	$A_{32}^{(3)}$	$A_{33}^{(3)}$	$A_{34}^{(3)}$	$A_{35}^{(3)}$
(3.4) investments at early stages	$A_{41}^{(3)}$	$A_{42}^{(3)}$	$A_{43}^{(3)}$	$A_{44}^{(3)}$	$A_{45}^{(3)}$
(3.5) the cost of information and communication technologies	$A_{51}^{(3)}$	$A_{52}^{(3)}$	$A_{53}^{(3)}$	$A_{54}^{(3)}$	$A_{55}^{(3)}$
(3.6) SMEs that have implemented organizational innovations	$A_{61}^{(3)}$	$A_{62}^{(3)}$	$A_{63}^{(3)}$	$A_{64}^{(3)}$	$A_{65}^{(3)}$

The source: developed by the author

The relative analysis involves the comparison of the known parameters for the structures that are considered (the USA, the EU, Japan, and the Rest of the world).

Each country's position is determined relative to one country, for example to the USA, if they agree to consider this country's indices as being equal to 1.

Moreover, the introduction of innovations proceeds differently in different countries (Table 5).

Table 5. Practical application of innovations (4) in the context of five events

Events (4)	USA	EU	Japan	The Rest of the world	Standard structure
	1	2	3	4	5
(4.1) employment in high-tech services	$A_{11}^{(4)}$	$A_{12}^{(4)}$	$A_{13}^{(4)}$	$A_{14}^{(4)}$	$A_{15}^{(4)}$
(4.2) the third-level education	$A_{21}^{(4)}$	$A_{22}^{(4)}$	$A_{23}^{(4)}$	$A_{24}^{(4)}$	$A_{25}^{(4)}$
(4.3) the penetration rate of the broadband access to scientific and innovative information on the Internet	$A_{31}^{(4)}$	$A_{32}^{(4)}$	$A_{33}^{(4)}$	$A_{34}^{(4)}$	$A_{35}^{(4)}$
(4.4) lifelong learning	$A_{41}^{(4)}$	$A_{42}^{(4)}$	$A_{43}^{(4)}$	$A_{44}^{(4)}$	$A_{45}^{(4)}$
(4.5) youth education	$A_{51}^{(4)}$	$A_{52}^{(4)}$	$A_{53}^{(4)}$	$A_{54}^{(4)}$	$A_{55}^{(4)}$

The source: developed by the author

The method of innovation acceleration is considered to be a possible method to assess alternative variants of the innovation process management, develop strategies and improve the effectiveness of new technologies.

It should be based on the comparative analysis of the current and the best variants of innovation activities.

Nevertheless, the comparative analysis of innovation activities in various countries should be regarded as a multi-stage process of strategic assessment.[5]

Intellectual properties of the population serve as the basis of innovation activities and can be measured, using 5 measure units presented in Table 6.

As you can see in Tables 1 - 6, various indices of science and technology development are expressed, with rare exceptions, by means of different incompatible units of measurement. Such indices cannot be compared to each other directly.

Table 6. Intellectual properties (5) in the context of five events

Events (5)	USA	EU	Japan	The Rest of the world	Standard structure
	1	2	3	4	5
(5.1) The number of patents granted by the European Patent Office	$A_{11}^{(5)}$	$A_{12}^{(5)}$	$A_{13}^{(5)}$	$A_{14}^{(5)}$	$A_{15}^{(5)}$
(5.2) The number of patents granted by the Patent and Trademark Office	$A_{21}^{(5)}$	$A_{22}^{(5)}$	$A_{23}^{(5)}$	$A_{24}^{(5)}$	$A_{25}^{(5)}$
(5.3) The number of patents registered in the EU, the USA and Japan	$A_{31}^{(5)}$	$A_{32}^{(5)}$	$A_{33}^{(5)}$	$A_{34}^{(5)}$	$A_{35}^{(5)}$
(5.4) The number of trademarks registered in EU countries	$A_{41}^{(5)}$	$A_{42}^{(5)}$	$A_{43}^{(5)}$	$A_{44}^{(5)}$	$A_{45}^{(5)}$
(5.5) The number of industrial implementations, registered in EU	$A_{51}^{(5)}$	$A_{52}^{(5)}$	$A_{53}^{(5)}$	$A_{54}^{(5)}$	$A_{55}^{(5)}$

The source: developed by the author

The comparative method of innovation activities allows developing composite indicators to synthesize available information in the context of the countries and regions that are considered; it allows combining a number of indicators, which characterize various aspects of innovation activities.

There is no universal indicator of science and innovation development. However, it is possible to calculate specific indicators, on the basis of which we determine the positions to compare the objects relative to each other [3].

In other words, the vector of all indices is standardized relative to one of the indicators, for example: the minimum value, the maximum value, the median value, standard deviations from anything (from average values or the mathematical expectation). Innovation activities are characterized by the following indicators: real values of expenditures, driving forces of innovation activities in the context of the indices of the countries that are studied.

We use the method of deviation to measure the deviation of the structure of actual activities from the virtual standard event. According to the English manual on mathematical modeling, the dot product of two vectors (a, b) is a scalar $(a,b) = |a| \cdot |b| \cos\gamma$, where γ is the angle between two vectors $a \text{ and } b$ [1]. Then:

$\cos\gamma = \frac{(a,b)}{|a| \cdot |b|}$.

Two non-zero vectors $a \text{ and } b$ are linearly dependent only if their cross product equals zero; and two non-zero vectors are mutually perpendicular, only if $(a,b) = 0$. If $(a,b) = 1$, then vectors $a \text{ and } b$ are identical. This means that when we use the method of deviations, the value of the function $\cos\gamma = 1$ means that vectors $a \text{ and } b$ are identical.

When determining the level of deviation of the considered actual vector from the virtual model vector, we compare angle γ with angle "0": the closer angle γ to zero, the closer the considered vectors to identity.

It is necessary to identify the vectors of the studied macro-events. We can arrange the countries in terms of deviation of macro-events from the macro-events of the model structure in the following way:

$a = (A_{15}, A_{25}, A_{35}, A_{45}, A_{55})$;

$b = (A_{11}, A_{12}, A_{13}, A_{14}, A_{15})$;

Next, we find the cosine of the angle between vectors:

$A_1 \text{ and } A_5; A_2 \text{ and } A_5; A_3 \text{ and } A_5; A_4 \text{ and } A_5,$

designated respectively by:

$\cos\gamma_{15}$; $\cos\gamma_{25}$; $\cos\gamma_{35}$; $\cos\gamma_{45}$.

$$\cos\gamma_{15} = \frac{\sum_{i=1}^{5} A_{i5} A_{1i}}{\sqrt{\sum_{i=1}^{5} A_{i5}^2} \cdot \sqrt{\sum_{i=1}^{5} A_{1i}^2}};$$

$$\cos\gamma_{25} = \frac{\sum_{i=1}^{5} A_{i5} A_{2i}}{\sqrt{\sum_{i=1}^{5} A_{i5}^2} \cdot \sqrt{\sum_{i=1}^{5} A_{2i}^2}};$$

$$\cos\gamma_{35} = \frac{\sum_{i=1}^{5} A_{i5} A_{3i}}{\sqrt{\sum_{i=1}^{5} A_{i5}^2} \cdot \sqrt{\sum_{i=1}^{5} A_{3i}^2}};$$

$$\cos\gamma_{45} = \frac{\sum_{i=1}^{5} A_{i5} A_{4i}}{\sqrt{\sum_{i=1}^{5} A_{i5}^2} \cdot \sqrt{\sum_{i=1}^{5} A_{4i}^2}};$$

The USA, the EU, Japan and the Rest of the World can be sorted depending on how close they are to the model structure in the process of innovation activities in terms of 5 macro-events.

The success of the proposed method to accelerate innovation at the level of individual countries, regions, unions, etc. largely depends on the quality of the information used.

The method of deviation of events from the events of the model structure should be applied with some caution. Some of the maximum (or minimum) values should be changed for the parameters, based on the complexity and specificity of the problem, since in some cases they compare the results obtained at different times and in different countries without taking into account the level of scientific development.

This approach on a more effective and efficient use of available resources in innovation can be used both at the level of certain regions and countries, and at the level of companies and industries. In our opinion, the approach is defined as a comparison between the best and the present variant of innovation organization.

At the same time, it should be noted that the standard that is being developed should be theoretically and practically justified. It must be the result of the combined progress, achieved by the participants of the economic processes that are considered to be leaders in implementing innovation.

One should use the comparative method to determine the best conditions for achieving economic goals, and as a result, to achieve the progress in the development, production and realization of competitive products and services.

Thus, those who participate in the international economy can compare various indices of the manufactured products and determine the place where the corresponding product can be produced most efficiently.

The method makes it possible to compare one's own achievements with the performance of the leaders in this field → to analyze how leaders managed to reach their position → to improve one's own activities, based on the data received.

The ultimate goal of the method is to improve innovation activities, analyzing the factors that affect the efficiency.

CONCLUSIONS

Own vision of long-term development of the world economy and the role of own country is not only important in determining the innovation policy strategy of the country, but also protecting its interests during international negotiations.

Innovation components are the determining factors of a long stable growth, created ecosystems during the crisis period and market short-cuts. They are also important to ensure viability and growth of innovative ecosystems in the countries with the developing economy, such as the Republic of Moldova.

The private sector is not interested or hardly ever interested in the scientific and research development. This is explained by a number of reasons, for example: imperfect legislation regarding the innovation control, and its absence in the field of venture capital, which is the basis for innovation in many countries of the world.

Reduced costs of goods and services that are produced enhance the country's competitiveness and economic independence. All economic programs of the country's development should be developed along with the development of forecasts at the global level, international demand for goods and services produced (or potentially produced) in the country. It is necessary to support the country's competitiveness in the field of a long-term economic analysis.

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