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SYMBOL COGNITIVE MAP FOR SCIENTIFIC AND TECHNICAL DEVELOPMENT OF REGIONS

The paper focuses on the necessity of considering the degree of association between the factors that affect the level of scientific and technological development of regions when classifying them by this feature. It justifies the use of the cognitive approach to achieve the task. The group of factors (concepts), influencing the level of scientific and technological development of regions, was determined. The authors analyzed the impact of each factor on the scientific and technological development of regions, the impact between factors and determined its place in the overall circuit of concepts. The symbol cognitive map of regions' scientific and technical development is presented.
Keywords: regional typology; cognitive approach; scientific and technological development of a region; cognitive map.
JEL classification: R1, R15.

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ЗНАКОВА КОГНІТИВНА КАРТА НАУКОВО-ТЕХНІЧНОГО РОЗВИТКУ РЕГІОНУ

У статті вирішено проблему типологізації регіонів за рівнем науково-технічного розвитку, що дозволяє враховувати ступінь зв'язку між факторами, які впливають на розвиток. Обґрунтовано доречність застосування когнітивного підходу до досягнення поставленої задачі. Виділено групу факторів (концептів), що впливають на рівень науково-технічного розвитку регіону та встановлено зв'язки між ними. Визначено місце кожного фактору в загальному ланцюзі концептів. Розроблено знакову когнітивну карту типологізації регіонів за рівнем науково-технічного розвитку.
Ключові слова: типологізація регіонів; когнітивний підхід; науково-технічний розвиток регіону; когнітивна карта.
Рис. 1. Літ. 10.

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ЗНАКОВАЯ КОГНИТИВНАЯ КАРТА НАУЧНО-ТЕХНИЧЕСКОГО РАЗВИТИЯ РЕГИОНА

В статье решена проблема типологизации регионов по уровню научно-технического развития, что позволяет учитывать степень связи между факторами, влияющими на развитие. Обоснована целесообразность применения когнитивного подхода для достижения поставленной задачи. Выделена группа факторов (концептов), влияющих на уровень научно-технического развития региона и установлены связи между ними. Определено место каждого фактора в общей цепи концептов. Представлена знаковая когнитивная карта типологизации регионов по уровню их научно-технического развития.
Ключевые слова: типологизация регионов; когнитивный подход; научно-техническое развитие региона; когнитивная карта.

Problem setting. The most pressing problem in regions today is grounding managerial decisions on the priorities in regional development. In this respect the classification of regions as management objects serves as a method of solving regional problems.

Regional typologies take a great number of approaches. The approaches mainly differ by the set of factors selected to consider a region of a particular type. When we analyze region as a complex system, not only the values of quantitative indicators of

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regions' development effectiveness matter but also the degree of association between them.

Taking into account the degree of association between indicators becomes possible through the use of cognitive approach.

Recent research and publications analysis. Cognitive regional economics is one of the promising areas of cognitive science development. The object of cognitive regional economics is the study of the processes of evaluation, selection and decision-making in economic activity; and explanation of the nature of the evolution of organizations and social institutions in terms of structural uncertainty. We should mention the following studies dedicated to the use of cognitive technologies in economy: J. Keynes (1920), F. Hayek (1945), G. Stigler (1998), P. Thagard (2005), D. Ross (2007), R. Topol and B. Walliser (2007), B. Walliser (2008), A. Kulinich (2010).

The research objective. The objects of the research are the indicators of scientific and technological development of regions. The objective of the research is to establish a set of indicators representing scientific and technical development of regions, determining the relationship between them and designing a cognitive map.

Key research findings. Application of cognitive approach is one of the most productive ways to solve the task at hand. The cognitive approach is relevant when the object of management and its environment appear to be a complex of difficult processes and factors affecting each other. Cognitive modelling methodology is also relevant to analysis and decision-making under uncertainty. The system of "region" can be considered too complex and unstable to use ordinary methods of analysis (Walliser, 2008; Kulinich, 2010).

Cognitive analysis is considered to be one of the most powerful tools for studying the unstable and semistructured environment. It contributes to better understanding of the problems existing in the environment, identifying contradictions and qualitative analysis of processes. The use of cognitive models enhances the validity of management decisions in a challenging quick-changing environment and releases the expert from "wandering", saving time for comprehension and interpretation of events that occur in the system (Primakov, 2004).

The "Scientific and Technological Development of a Region" superconcept covers 12 concepts. They are: Gross Regional Product (GRP); sales of innovative products; quantity of innovative products sold abroad; share of innovative products in the total exports; share of innovative products in industrial products sales; number of patents; learning new trades; continuing professional development; share of employees with higher academic degrees in scientific organizations; R&D funding; R&D funding per employee; R&D intramural expenditures.

The task at hand is to make the cognitive map that should reflect the links between these concepts. Before we show the links between the concepts on the cognitive map, let us consider them separately in terms of impact on scientific and technological development of a region.

1. Sales of innovative products. As mentioned above, innovations become the main priority in today's economy. Effectiveness of innovative processes taking place in the country is reflected in the indicator of innovative products sales volume. It is the innovative product sold by each separate company which guarantees its competitiveness at domestic and international markets and is the basic prerequisite for maximizing profits.

Thus, on the cognitive map of "Scientific and Technological Development of a Region", the concept of innovative products sales takes up the central position affecting GRP.

2. The quantity of innovative products sold abroad. Nowadays, innovative development of countries at the world market is commonly estimated by the Global Competitiveness Index. The quantity of innovative products exported by a country is among the figures taken into account while calculating the index. It is the quantity of innovative products sold abroad which measures the technological development of regions and country as a whole at the global market. Within "Scientific and Technological Development of a Region" this concept is resulting, but its level depends on the concepts described below.

3. Share of innovative products in total exports. This concept is close to the previous one. The only difference between them is that the previous shows the total amount of innovative products exported by a country and this indicator shows how innovative are the exported products.

4. Share of innovative products in industrial products sales. Provided that scientific and technological development of Ukrainian regions is funded mainly at the expense of industrial enterprises, the industrial sector is considered to be the most innovative. That is why this concept shows the level of innovation by regions. So we associate this concept with the number of patents and sales of innovative products on the cognitive map.

5. Number of patents. This concept affects the previous 4 because each innovative product must be patented. The concept of sales of innovative products has a direct connection to the number of patents. The number of patents obtained, in turn, is affected by the group of concepts stated below.

6. Learning new trades. It is one of the factors contributing to scientific and technological development of regions by the improvement of not only socioeconomic indicators of a region, but also science and technology. The concept of learning new trades contributes to the ability of employees and organizations to promote innovative processes through the development of inventions and obtaining patents.

7. Continuing professional development. Continuing professional education of employees of industrial companies and organizations increase the scientific and technical level of processes they are involved in. As with learning new trades, continuing professional development increases the number of patents and raises productivity.

8. Share of employees with higher academic degrees in scientific organizations. Considering the total number of scientific developments in the country we can see that most of them are performed in research institutions by employees with degrees. That is why this concept proves to be the factor that directly influences innovations in a region and its scientific and technological development.

9. R&D funding. This is obvious that whatever are the human resources of the country, financial element is always the most important one for scientific and technological development.

10. R&D funding per employee. If the previous concept determines the volume of total funding for research and development, this indicator encourages human potential to contribute to it. So this concept has a direct connection with learning new trades, share of employees with higher academic degrees and continuing professional development.

11. R&D intramural expenditures. As mentioned above, R&D activities in organizations are usually funded at own expense so the weight of this concept is very high. In the "Scientific and Technological Development of a Region" this concept is connected with R&D funding per employee and through it − with learning new trades, continuing professional development and the share of employees with higher academic degrees.

12. Gross Regional Product (GRP). Innovative development of regions of a country is mainly based on the achievements of science and engineering. Innovative development is the most important element in contemporary civilization. Today's economy cannot be imagined without its innovative component. It has become the basis for developed countries and some developing countries. The feature of new innovative economy is that the process of distribution, creation and implementation of new knowledge is decisive in shaping the strategies of territorial development, which provides a proper combination of economic, social and natural components for harmonious development of regions. It should be highlighted that the sector that produces knowledge and converts it into products consumed by people is growing with outstripping growth rate. Thus, the volume of the world market of high-tech products in 2006 was 3.3 trln USD, and by 2020 it may reach 10 trln USD (Primakov, 2004; Chulok, 2006).
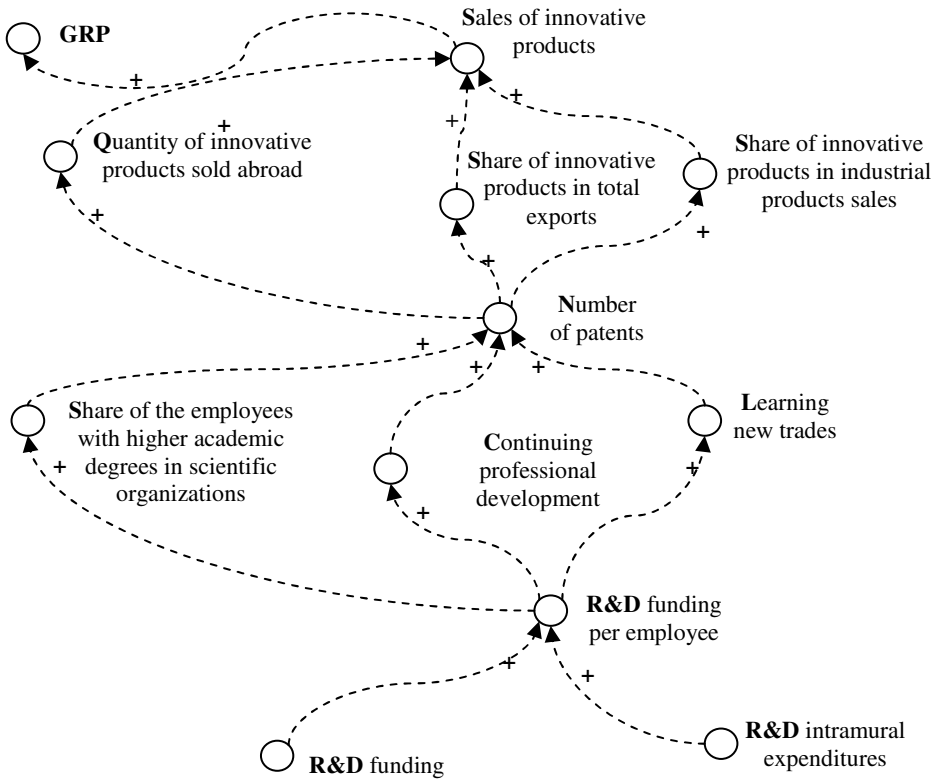

Figure 1. **Symbol Cognitive map "Scientific and Technological Development of a Region",** *developed by the authors*

The analysis of items within the "Scientific and Technological Development of a Region" resulted in the cognitive map formations presented in Figure 1. On the symbol cognitive map the relation between two factors is marked with "+" when an increase in one factor causes an increase in the other, or when a decrease in one factor leads to a decrease in the other. The relation between two factors is marked with "-" when an increase in one factor leads to a decrease in the other, or when a decrease in one factor leads to an increase in the other.

This cognitive map provides visual representation of the relationships between the concepts that influence the level of region's industrial development. In addition, the map shows the circuits that may be affected in order to achieve the required change in a particular factor. At the next stage of application of the cognitive map of regional industrial development we should build the balanced cognitive map, where the links between the concepts have numerical expression of the degree of connection in the range from 0 to 1. The weighted cognitive map should be made for each separate region based on its performance. It may allow not only assessing the relationships between the concepts in a region but also identifying the ways of organizational and economic interventions in chains with weak cognitive connections.

Basing on the results of the study the **following conclusions** were made:

1. A region of a country as a management object can be considered too complex and unstable to use ordinary methods of analysis.

2. The cognitive approach application is an effective way to analyze regions and classify them by the level of development basing on the degree of connection between factors (concepts).

3. The cognitive map of regional typology by the level of scientific and technical development allows:

- identifying weaknesses in each region of a country, in order to establish efficient operation of the entire system;

- effective economic and organizational decision-making concerning regional development;

- increasing the effectiveness of measures aimed at the development of all spheres of a region, because in a system with strong relationships between all circuits the measures implemented may have faster and better effects.

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