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Analysis of innovative industrial competitiveness: methodological and applied aspects

Abstract. The realization of the innovation-driven stage of economic development combined with an increase in the innovation competitiveness of the objects of various levels (a country, a region, a municipal entity, an organization) is hampered by the absence of specialized methodological toolkit. This problem is even more acute at the level of industrial enterprises. The mentioned circumstances determine the content of the article which is aimed at presenting the authors' methodology used to assess the innovative competitiveness of industrial enterprises as well as its pilot testing the results. The paper presents a definition of the innovation-driven competitiveness of industrial enterprises, which establishes the appropriateness of its assessment according to the level of the innovative potential development. We have emphasized the key methodological aspects related to the model diagnostic algorithm and analyzed the consolidated results of the study. The applied aspect of the methodology related to validation of management impacts as well as financing priorities (subsidy) in regard to industrial enterprises is stressed in the research.

Keywords: Innovative Competitiveness; Innovation Capacity; Industrial Enterprise; Assessment Methodology

JEL Classification: B41; D00; H23

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Анализ инновационной конкурентоспособности промышленных предприятий: методический и прикладной аспекты

Аннотация. Реализация инновационного этапа развития экономики, сопряженного с повышением инновационной конкурентоспособности разноуровневых (страна, регион, муниципальное образование, организация) объектов, во многом тормозится отсутствием профильного методического инструментария. Особенно остро данная проблема проявляется на уровне промышленных предприятий. Отмеченные обстоятельства определили содержание статьи, нацеленной на представление авторской методики оценки инновационной конкурентоспособности промышленного предприятия и результатов ее пилотной апробации. В работе дается определение инновационной конкурентоспособности промышленного предприятия, обосновывающее правомерность ее оценки по уровню развития инновационного потенциала; внимание акцентируется на ключевых методических аспектах; приводится типовый алгоритм диагностики; анализируются сводные результаты исследования. В резюме работы подчеркивается прикладной аспект использования методики, заключающийся в возможности обоснования управленческих воздействий и приоритетов финансирования (субсидирования) инновационных промышленных предприятий.

Ключевые слова: инновационная конкурентоспособность; инновационный потенциал; промышленное предприятие; методика оценки.

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Аналіз інноваційної конкурентоспроможності промислових підприємств: методичний та прикладний аспекти

Анотація. Реалізація інноваційного етапу розвитку економіки, пов'язаного з підвищенням інноваційної конкурентоспроможності різнорівневих (країна, регіон, муниципальне утворення, організація) об'єктів, багато в чому гальмується відсутністю профільного методичного інструментарію. Особливо гостро дана проблема проявляється на рівні промислових підприємств. Зазначені обставини визначили зміст статті, націленої на представлення авторської методики оцінки інноваційної конкурентоспроможності промислового підприємства та результатів її пилотної апробації. У роботі дається визначення інноваційної конкурентоспроможності промислового підприємства, який обґрунтовує правомерність її оцінки за рівнем розвитку інноваційного потенціалу; увага акцентується на ключових методичних аспектах; наводиться типовий алгоритм діагностики; аналізуються зведені результати дослідження. У резюме роботи підкреслюється прикладний аспект використання методики, що полягає в можливості обґрунтування управлінських впливів і пріоритетів фінансування (субсидування) інноваційних промислових підприємств.

Ключові слова: інноваційна конкурентоспроможність; інноваційний потенціал; промислове підприємство; методика оцінки.

1. Introduction

At the current stage of economic development, the competitiveness of entities at various levels (a country, a region, a municipal entity, an organization) is largely determined by the degree of their innovativeness. One cannot argue the fact that «the only proper way to improve the competitiveness is to apply an innovative approach as the most universal and the most appropriate one» [1]. As a result of the given circumstances, there appeared the term «innovation competitiveness» along with its logical continuation which is considered to be the elaboration and development of an appropriate methodological toolkit.

The problem is most acute at the micro level. Taking into account the sectoral structure of the Russian economy, assessment of the innovative components of industrial enterprises is considered to be the most urgent task.

2. Brief Literature Review

Theoretical considerations and methodological aspects of investigating the competitiveness are presented in the works of well-known foreign scientists, such as M. Albert, A. Dayan, P. Drucker, Ph. Kotler, A. Ollivier, M. Porter and others. In the context of the defined problem, the works of leading Ukrainian [2; 3] and Russian [4-10] researchers, who justify the importance of the innovative component of the competitiveness of industrial enterprises in the specific conditions of economic activities, deserve particular attention. Thus, analyzing the linkages between competitiveness and innovativeness, V. Hrozna concludes that «innovative activity can be seen as a means to increase the competitive capacity» [2, 130]; V. Shuvalov emphasizes that «today, innovations are becoming one of the main resources, determining the competitiveness of enterprises» [4, 28]; T. Kolosova claims that «an increase in innovations relevant to economic development is aligned to the principal priorities of industrial enterprises» [7, 46]; N. Podhora, in the context of innovation management, points out a need for the commercialization of the technical base of enterprises and introduction of innovation projects. Unfortunately, scientists centering on conceptual aspects and applications of innovative competitiveness have overlooked methodological issues.

3. The Purpose of the article is to provide methodological approaches to the assessment of innovative competitiveness of industrial enterprises and the results of their pilot testing at the example of the so-called enterprises of basic experiment.

4. Results

Without going into a discussion related to the main concepts of the «competitiveness of an enterprise» [6; 8; 10] and the «innovative potential of an enterprise» [12-13], we find it necessary to understand by the concept of innovative competitiveness of an enterprise a relative characteristic of the subject, which reflects the ability to win an economic competition in a particular market due to a higher level of development of the innovative potential. The theoretical and methodological aspect related to justification of the appropriateness of the assessment of innovative competitiveness of enterprises according to the development level of the innovative potential is of great importance.

The conceptual framework of the authors' methodological toolkit is based on the idea of using the Harrington's nomogram, which enables us to conduct a level assessment of different parameters according to the model (standard) indicators (1.00 – the high level; 0.80 – the level above the average; 0.63 – the average level; 0.37 – the level below the average; 0.20 – the low level). The nomogram is successfully implemented by many scientists to assess product marketability [14], the quality of work life of the staff members [15], the current staff situation [16], etc.

The key component of the methodology is the Chart of expert assessment accumulating descriptive and/or quantitative characteristics of the analyzed parameters which are distinguished according to the model gradation levels. The supplied template (Table 1) could be used as a basis for assessing the level of development of the innovative potential of industrial enterprises.

The following five components are positioned as basic structural determinants of the innovative potential:

- 1) the staffing component characterizing professional competence and readiness of employees for innovation activities, which is identified by a level of innovation competitiveness of the staff (L_{ICS});
- 2) the technical and technological components reflecting a degree of conformity between the technology or equipment used and the reference (either foreign or domestic) equipment samples, which is identified by a level of technical and technological development (L_{TTD});
- 3) the production component characterizing the range of output products, which is associated with a level of innovativeness of production (L_{IP});
- 4) the financial and economic component reflecting a degree of availability of an enterprise's own resources and the proportion of internal costs of innovative developments, which is identified with the level of financial and economic development (L_{FED});
- 5) the infrastructure component reflecting the presence of elements of the innovation infrastructure required for conducting innovative activities and the effective implementation of innovation processes, which is associated with a level of development of the innovatory structure (L_{DIS}).

It appears that the level of innovative competitiveness of industrial enterprises (L_{IC}), which is identified according to the level of development of innovative potential (L_{DIP}), can be calculated by the formula given below:

$$L_{IC} = L_{DIP} = L_{ICS} * d_{ICS} + L_{TTD} * d_{TTP} + L_{IP} * d_{IP} + L_{FED} * d_{FED} + L_{DIS} * d_{DIS}, \quad (1)$$

where d_{ICS} , d_{TTP} , d_{IP} , d_{FED} , d_{DIS} are the proportional factors reflecting the relative value of the relevant components (i.e. the staffing component, the technical and technological component, the production component, the financial and economic component, the infrastructure component) determining the innovative potential in fraction per unit.

Tab. 1: Model chart template for expert assessment of development levels of industrial enterprises' innovative potential

Components of the innovative potential development level	Relative value of the innovative potential components	Gradation levels of industrial enterprises' innovative potential development				
		0.20	0.37	0.63	0.80	1.00
Level of innovation competitiveness of the staff (L_{ICS})	d_{ICS}	Descriptive and/or quantitative characteristics of the staffing component of innovation potential				
Level of technical and technological development (L_{TTD})	d_{TTD}	Descriptive and/or quantitative characteristics of the technical and technological component				
Level of innovativeness of production (L_{IP})	d_{IP}	Descriptive and/or quantitative characteristics of the production component				
Level of financial and economic development (L_{FED})	d_{FED}	Financial and economic component				
Level of development of innovative structure (L_{DIS})	d_{DIS}	Descriptive and/or quantitative characteristics of the infrastructure component				

Source: Own development based at Harrington's nomogram

It is clear that the foregoing list of structural components of the innovative potential of industrial enterprises (Table 1) is not exhaustive and allows for adjustments relevant to both expansion of the list and its downward revision (down to one or two the most important components). The latter develops the concept of express diagnostics. An analysis of specialized literature enables us to conclude that there exist two prevalent (main) components of the innovative potential of industrial enterprises – the staffing and the technical and technological ones with their aggregate relevance equal to about 70%. Hence, in express diagnostics of the innovative competitiveness of industrial enterprises it is acceptable to use the formula given below:

$$L_{IC} = L_{DIP} = L_{ICS} * d_{ICS} + L_{TTD} * d_{TTP}, \quad (2)$$

Taking into account the abovementioned considerations as to the level of innovative competitiveness as well as concretization of the Model chart template for expert assessment (Table 1), it would appear logical to comprehend $d_{ICS} = 0.40$ when assessing a level of development of innovative potential by the five structural components and $d_{TTP} = 0.57$ when conducting express diagnostics by the two components. The innovative competitiveness of the working staff being understood as a degree of consistency between its qualitative characteristics such as the level of qualifications relevant to professional skills and abilities, the level of education, age and working experience which determine the level of professional competitiveness as well as the level of motivation towards innovative activities and the objective characteristics of the workplace [17], it becomes possible to define the following descriptive characteristics of the gradation levels:

- the high level of innovative competitiveness of the staff (1.00) – all the qualitative characteristics of the staff (the level of qualifications relevant to professional skills and abilities, the level of education, age and working experience) are in full compliance with objective characteristics of the workplace; a high level of motivation towards innovative activities is reported; the motives for innovation (i.e. creativity at work, innovation-related activities, benefits for the implementation of innovations in production, etc.) clearly prevail in the motivational profile of the staff;
- the level above the average (0.80) – the level of qualifications relevant to professional skills and abilities as well as the level of education of the staff is in full compliance with the objective characteristics of the workplace, whereas the other components of professional competitiveness may slightly differ from the reference ones; a high level of motivation towards innovative activities is reported; the motives for innovation clearly prevail in the motivational profile of the staff;
- the average level (0.63) – the level of qualifications relevant to professional skills and abilities as well as the level of education of the staff is in full compliance with the objective characteristics of the workplace; the other qualitative characteristics of the staff (i.e. age and working experience) differ from the reference ones; a sufficient (i.e. average or above the average) level of motivation towards innovative activities is reported; «mixed» (both innovative and traditional) motives prevail in the motivational profile;
- the level below the average (0.37) – the level of qualifications of the staff relevant to their skills and abilities is in full compliance with the objective characteristics of the workplace, whereas the other qualitative characteristics of employees (i.e. the level of education, age and working experience in a given occupation) are in varying degrees different from the reference ones; the average level of motivation towards innovative activities is reported; the «mixed» motives prevail in the motivational profile;
- the low level (0.20) – all the qualitative characteristics of employees which concern their professional competitiveness are in varying degrees different from the reference ones; an insufficient (i.e. below the average or low) level of motivation towards innovative activities is reported; traditional motives clearly prevail in the motivational profile of employees.

According to the same principle, which assumes partial transformation of the given parameters from one gradation level to another, we provide descriptive characteristics of other components of innovative potential of industrial enterprises. For example, to reflect changes in the technical and technological component we should consider parameters such as the development level of production processes, the level of mechanical wear of the equipment, the level of adoption of advanced technologies (a ratio of technological innovations), a possibility of transfer of the unique technologies, etc. We can consider the following parameters while describing gradation levels of the innovation-related production potential of industrial enterprises: a ratio of innovative products to the total value of production, a share of products undergoing a significant technological change, the availability of unique products, etc.

When assessing the components of innovative potential, it might often be the case that the choice between the two adjacent levels is complicated. In such cases, we recognize the mean (average) value. For example, if we have doubts concerning the values 1.00 and 0.80, we recognize the value of 0.90; if we have doubts concerning the values 0.80 and 0.63, then we recognize the value of 0.72; when it comes to the values 0.63 and 0.37, we recognize the value of 0.50; when choosing between 0.37 and 0.20, the value of 0.29 is taken into account. On the basis of the given considerations, we have justified the range of gradation levels relevant to innovative potential and innovative competitiveness (Table 2).

Range of changes in the level of innovative potential development	Characteristics of innovative potential levels	Characteristics of innovative competitiveness levels
from 0.90 to 1.00	excellent	high
from 0.72 to 0.89	good	average
from 0.50 to 0.71	acceptable	low
from 0.20 to 0.49	problematic	—

Source: Own development based at Harrington's nomogram

A consistent systematization of the abovementioned methodological aspects enabled us to justify the algorithm for industrial enterprises' innovative competitiveness assessment based on implementation of the following:

1. Establishment of an expert group by selecting among leading outside specialists and representatives of the directorate of the enterprise.
2. Justification of the relative value of the analyzed innovative potential components by the experts.
3. Elaboration of the Chart of expert assessment of industrial enterprises' innovative potential (Table 1), which combines the descriptive characteristics of gradation levels with regard to the analyzed components.
4. Identification of the attained levels of the analyzed components of innovative potential according to the Chart of expert assessment.
5. Calculation of the industrial enterprises' level of development of innovative potential (L_{DIP}) by Formula 1.
6. Identification of the industrial enterprise's attained level of innovative competitiveness according to Table 2.

In the spring of 2015, the proposed methodological toolkit was successfully tested at four industrial enterprises, such as CJSC Evalar, CJSC Altaivitamin, Pantoproekt LLC and Spetsialist LLC, which are part of the non-profit partnership Altai Biopharmaceutical Cluster. The conducted express diagnostics of the level of innovative potential was based on the assessment of the following components: the level of innovative competitiveness of the staff (with its relative value of 0.57) and the level of technical and technological development (with its relative value of 0.43). To observe the rules of business ethics, the analyzed enterprises are represented under the given numbers in Table 3 which reflects the major findings.

5. Conclusions. The proposed methodology, which was successfully tested, has fully proved its intended purpose. Its focus on the level (relative) assessment of the studied param-

Tab. 3: Aggregate results of the analyzed enterprises' innovative competitiveness diagnostics

Diagnostic parameters	Notional numbering of enterprises under analysis			
	No. 1	No. 2	No. 3	No. 4
Level of innovation competitiveness of the staff (L_{IC})	0.90	0.80	0.72	0.80
Rank of the enterprise according to innovation competitiveness of the staff	1	2	3	2
Level of technical and technological development (L_{TD})	0.90	0.63	0.63	0.80
Rank of the enterprise according to the level of technical and technological development	1	3	3	2
Level of development of innovative potential of the enterprise (L_{DIP})	0.90 (excellent)	0.73 (good)	0.68 (acceptable)	0.80 (good)
Level of innovation competitiveness of the enterprise (L_{IC})	0.90 (high)	0.73 (average)	0.68 (low)	0.80 (average)
Integral rank of innovation competitiveness of the enterprise	1	3	4	2

Source: Own research of Altai Biopharmaceutical Cluster, 2015

ters enables us to rank the enterprises under analysis according to specific and integral indicators of innovative competitiveness. This, in turn, allows us to determine aspects of management and financing priorities (e.g. the amount and prioritization of public subsidies) under conditions of limited resources.

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