

Modern approach to evaluate neo-industrial enterprise innovative capacity

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Abstract—Innovative capacity of the neo-industrial enterprise is now a widely used concept in business and industrial policymaking. This article examines the methodological approach to evaluation of the enterprise assets, namely its innovative capacity, under conditions of limited resources. The research is aimed at identifying and evaluating the resource needs for innovative enterprise development to support its sustainable competitiveness in the external and internal markets under conditions of new industrialization. The pivotal issues of assessment of resources’ sufficiency for implementing the innovative development program are examined as well as the complex integrated assessment method of innovative capacity of the neo-industrial enterprise is elaborated. Resources are considered in terms of their domains and functional areas of the enterprise activity. The research deals with the concept of “innovative capacity”, the features of its formation and development. The emphasis is placed on indicators’ values, their multidirectional impact on final assessment. This methodological approach based on quantitative criteria will permit to prove the choice of options for implementing the innovative development program of neo-industrial enterprises, taking into account the variability of the market environment.

Keywords — *innovative capacity; neo-industrial enterprise; integrated assessment; multidirectional impact of indicators; resources*

I. INTRODUCTION

The present stage of the domestic economy development is marked by an increasing role of innovative development strategy in neo-industrial enterprise activity. Innovative development is a prerequisite for vigorous growth

of the majority of economic entities in the neo-industrial sector of the economy. The successful implementation of the program of neo-industrial enterprise innovative development is highly dependent on the resources available.

In terms of neo-industrial enterprise innovative development, “resources” are regarded as a set of interrelated assets of the economic entity required to implement the innovative development program in the most efficient way.

A generalized analysis of diverse classifications of resources [1, 2, 3] revealed the dependence of singling out particular resources on the goals and objectives of the research.

The goal of the research is to identify and evaluate the resource needs for the enterprise innovative development to provide its sustainable competitiveness in the external and internal markets based on indicators of innovative capacity. Accordingly, the following types of resources required by neo-industrial enterprises to implement its innovative development program are of primary importance:

- Material resources that are a set of various types of raw materials, supplies, fuel, energy, spare parts, semi-manufactures, etc., required by the neo-industrial enterprise to produce goods and provide services.
- Scientific and technical resources that are a set of facilities, machines, equipment, production technologies, patents, licenses, know-how, etc.

- Financial resources that are an amount of monetary funds available for the neo-industrial enterprise to generate necessary assets to implement the innovative development program.
- Human resources that are the main asset of the neo-industrial enterprise that embraces intelligence, skills and employee expertise.
- Information resources that are a set of data and knowledge strategically vital for the neo-industrial enterprise performance.

To successfully implement the program of neo-industrial enterprise innovative development, it is necessary to match the identified need in resource supply to the value of the innovative capacity of this economic entity.

II. RELEVANCE

To elaborate efficient mechanisms for the emergence, distribution, and use of innovations is becoming increasingly challenging nowadays. Consequently, there is a pressing need for assessing the value of the innovative capacity of the neo-industrial enterprise.

The neo-industrial enterprise management needs to have proper reliable information related to the value of its innovative capacity for planning, forecasting, making effective managerial decisions concerning innovations. In general, the innovative capacity represents quantitative assessment of the set of various available types of resources of the business entity, required for providing its innovative activity. It serves as an indicator whether the neo-industrial enterprise is ready to implement a set of measures developed as part of the innovative development program.

Disparity between estimated values of the innovative capacity of the neo-industrial enterprise and the resource requirements for its innovative development (i.e. the value of the innovative capacity is lower than the identified resource requirements) is the indicator for the urgent need to improve the previously elaborated innovative development program of this economic entity. The choice of the particular innovative development program depends on the state of innovative capacity; therefore, its evaluation becomes a significant step in the strategy implementation of the neo-industrial enterprise innovative development.

III. MAIN PROBLEM

The notions and ideas related to the general category of “capacity” or “potential” in natural sciences and philosophy have become the methodological basis for the study of the “innovative capacity” concept.

Currently, there are several approaches to the definition of the “capacity” concept. The analysis of the scientific works of some distinguished scholars [4, 5, 6, etc.] concluded that the scope of the term “capacity” is largely determined by the specific character of the field it is used in.

In general, the term “capacity” could be interpreted as the possibility of the system to transfer from one state to another by means of resources available. The concept of

“innovative capacity” was introduced by the famous economist K. Freeman in the early 80's of the twentieth century. [7]. He defined the term “innovative capacity” as a factor, which ensured the system growth due to innovations [8].

So far, economists focus a great deal of attention on the study of the formation and determination of innovative capacity. However, the data presented in the majority of scientific papers is rather complex and controversial matter.

Though there seems no unified approach to the notion of the term “innovative capacity” [9, 10, 11, 12, 13, 14, 15], still it is possible to identify some common features that reflect the essence of this phenomenon:

- A set of material, technical, financial, human and other types of resources required to implement the elaborated program of innovative development of the economic entity.
- Degree of willingness of the economic entity to introduce and implement innovations.
- Opportunities of the economic entity to implement innovative activity.

Consequently, the innovative capacity is an integrated economic indicator, which indicates the degree of willingness of the neo-industrial enterprise to implement efficient productive innovative activity. It is manifested in availability of its material, scientific, technical, financial, human and information resources required to implement activities within the framework of the elaborated program of innovative development.

Currently, a unified method of innovative capacity assessment has not been properly developed yet due to various interpretations of its nature in the economic literature. Most of the approaches tend to assess the total value of the innovative capacity either due to its financial (cost) component, or to calculation of a weighted integrated index based on expert assessment method. [13, 14, 15, 16, 17]. The practical application of these methods is quite challenging since the external environment in which the neo-industrial enterprise operates is marked by a high degree of uncertainty. Therefore, it is quite difficult to give financial assessment and identify the role of a particular value component of the company innovative capacity.

IV. EVALUATION METHODS DEVELOPMENT

The main requirements for the assessment method of the innovative capacity of the neo-industrial enterprise are as follows:

- The use of standardized quantitative indicators to assess the state of available resources of the neo-industrial enterprise required for implementation of the innovative development program.
- Ensuring the completeness of the data used to calculate set of indicators.

- The use of the integrated indicator, which includes coherent assessment from private quantitative indicators to the total value indicator of the innovative capacity.
- Identification and consideration of the multidirectional impact of private quantitative indicators on the value of the final integrated assessment of the innovative capacity.
- Calculation of the integrated indicator of the innovative capacity value for every domain and functional area of the neo-industrial enterprise activity.

The formulated requirements for the assessment method of the innovative capacity value of the neo-industrial enterprise are considered further in more detail.

To implement the innovative development program, the neo-industrial enterprise requires the following types of resources: material; scientific and technical; financial; personnel and informational ones.

For quantitative assessment of the resources specified, the following set of indicators is used:

- Material factors: quality assessment of physical facilities' plans; estimate of material resources demand; the share of inventories in current assets; ratio of geographical location rate of required material resources.
- Scientific and technical factors: the share of fixed assets; wear and tear factor of fixed assets; the suitability index of fixed assets; intensity of use of fixed assets; capacity utilization of necessary equipment; the share of freight cost in the cost of goods; level of data groundwork; labor efficiency; automation level.
- Financial factors: the own funds ratio; equity to total assets; leverage ratio; current ratio.
- Personnel factors: manpower distribution; personnel lapse factor; percentage of trained labour; personnel training and retraining ratio.
- Information factors: effective use of information; efficiency of automated management system; computerization level; level of availability of electronic reference systems.

This indicator list is open and can be supplemented due to specifics of the implemented innovations.

After quantitative assessment of all resources required for the implementation of the innovation development program; it is necessary to calculate the total innovative capacity of the "j-th" functional area, which can be represented as the following functional dependence:

$$IC_j = f(x_1, x_2, x_3, x_4, x_5), \quad (1)$$

x_1 – material resources; x_2 – scientific and technical resources; x_3 – financial resources; x_4 – human resources; x_5 – information resources.

Most economists calculate the weighted arithmetic average to interpret the integrative indicator of the innovative capacity of the economic entity. Moreover, for assigning weighting coefficients to different types of resources, the authors of the approaches studied suggest using the Delphi method. This method can be used to calculate the integrated indicator of the actual innovative capacity value, provided every resource component is recognized. Specificity of most investigated neo-industrial enterprises under conditions of high uncertainty of the external environment does not allow to evaluate the role of each resource component while forming the innovative capacity. In this regard, above-mentioned assessment methods for innovative capacity cannot easily be applied to the neo-industrial enterprise performance in terms of time or material costs.

The innovative capacity of the "j-th" functional area of the neo-industrial enterprise can have a large range of values depending on the policy adopted by the company management towards requirements for the selected indicators. Each indicator mentioned above can significantly affect innovative capacity; however, its change causes changes in other indicators. For instance, purchasing several expensive patents allows the economic entity to launch high-tech products to the market in the long run and occupy a highly demanded niche; but this can reduce the current ratio of this company in a certain period "t". Moreover, value increase of such indicators as physical facilities provision ratio as planned; the actual material resources provision ratio; estimate of material resources demand; the share of inventories in current assets; the share of fixed assets required in total assets; the suitability index of fixed assets; level of data groundwork; labour efficiency; automation level; the own funds ratio; equity to total assets; current ratio; manpower distribution; percentage of trained labour; personnel training and retraining ratio; effective use of information; efficiency of automated management system; computerization level; level of availability of electronic reference systems aim at increasing innovative capacity. And the increase of such indicators as ratio of geographical location rate of required material resources; wear and tear factor of fixed assets; extensive capacity utilization of necessary equipment; intensive capacity utilization of necessary equipment; capacity utilization of necessary equipment; the share of freight cost in the cost of goods; leverage ratio; personnel lapse factor, consequently result in decrease of innovative capacity.

In this regard, the integrated assessment of the innovative capacity of the neo-industrial enterprise, which takes into account all the relevant indicators, is considered the most rational and appropriate.

V. RESULTS AND DISCUSSION

Therefore, the method of forming the integrated indicator of the innovative capacity of the neo-industrial enterprise will include the following steps:

1) *Determination of the structure, values and directions of target indicators' impact at the first stage of the innovative development program (x_i by program, y_i by program).*

2) *Calculation of the values of indicators that increase (x_i) and decrease (y_i) the value of the total innovative capacity of the neo-industrial enterprise using the formulas:*

$$x_i = \frac{A_i}{B_i}, \quad (2)$$

A_i – numerator values of increasing indicators; B_i – denominator values of increasing indicators.

$$y_i = \frac{C_i}{D_i}, \quad (3)$$

C_i – numerator values of decreasing indicators; D_i – denominator values of decreasing indicators.

3) *Calculation of present values of increasing (X_i) and decreasing (Y_i) indicators:*

$$X_i = \frac{x_i}{x_{by}}, \quad (4)$$

$$Y_i = \frac{y_i}{y_{i \text{ by program}}}. \quad (5)$$

4) *Calculation of the integrative assessment of the innovative capacity of the neo-industrial enterprise by subsequent functional dependence:*

$$IC_j = \frac{1}{\sqrt{\sum (1-x_i)^2 + (\sum Y_i)^2}} \quad (6)$$

According to the numerical composition of the increasing and decreasing indicators used to determine the value of the total innovative capacity, the limit (“ideal”) value of the calculated integrative indicator in each case will vary. For instance, if the total value of the innovative capacity includes all the indicators proposed above, eight of which will have a decreasing value; then the maximum permissible (“ideal”) value of the integrated indicator will be 0.354. Thus, the condition of the neo-industrial enterprise innovative capacity can be marked by the following value ranges:

- $IC \in [0;0,0885)$ – unacceptably low level of the innovative capacity.

- $IC \in [0,0885;0,177)$ – low level of the innovative capacity.
- $IC \in [0,177;0,2655)$ – satisfactory level of the innovative capacity .
- $IC \in [0,2655;0,354)$ – high level of the innovative capacity .
- $IC=0,354$ – maximum level of the innovative capacity.
- By denoting the calculated values of the integrated indicator of the innovative capacity value within the maximum possible sets of increasing and decreasing indicators as “ M_{IC} ” and following the similar logic, let us define the value ranges that will characterize the condition of innovative capacity of the neo-industrial enterprise in a given situation. (table 1).

TABLE I. THE VALUES OF THE LEVELS OF INNOVATIVE CAPACITY

Range settlement values	Characteristics of innovative capacity
$[0 \dots 0,25 M_{IC})$	Unacceptably low level of the innovative capacity
$[0,25 M_{IC} \dots 0,5 M_{IC})$	Low level of the innovative capacity
$[0,5 M_{IC} \dots 0,75 M_{IC})$	Satisfactory level of the innovative capacity
$[0,75 M_{IC} \dots M_{IC})$	High level of the innovative capacity
M_{IC}	Maximum level of the innovative capacity

- Moreover, the top management, setting the target values of “input” indicators, defines them as a range, based on its own knowledge, or sets the borders of these indicators taking into consideration reserve stock.

In this regard, the calculated values of the integrated indicator of the innovative capacity value assessment will have fluctuations related to the spread of values of the specified target indicators. According to the calculation results, it may turn out that the limit of unacceptable and acceptable values of the integrated indicator will be within the calculated interval of the total innovative capacity. This will be an impetus for management staff to more accurately determine the range of “input” target parameters.

5) *Comparison of the innovative capacity value to the resources required to implement the innovative development program. If the estimated value of the integrated indicator of the innovative capacity assessment is “ $0.5M_{IC}$ ” or less, the elaborated program of the neo-industrial enterprise innovative development should be adjusted to reduce the number of announced measures. The other way is to gradually implement the activities submitted in the innovative development program, taking*

into account constant verification of the ratio of the company current innovative capacity and the actual resource need in each activity or measure.

VI. CONCLUSION

The proposed method for evaluating the innovative capacity of the neo-industrial enterprise based on the quantitative integrative criterion, allows to assess its value taking into account the specifics of domains and functional areas of the enterprise activity. Application of the elaborated methodology to actually assess innovative capacity will result in implementing the innovative development strategy of the neo-industrial enterprise in the most efficient way. Moreover, the input performance indicators can be justified and improved in order to provide the most efficient activity compared to the rival indicators that are significant in current and projected market conditions.

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