

Determining the potential of organizational structures models of a high-tech cluster

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Abstract. As a rule, during the choice of the most viable organizational structure of a cluster, traditional methods of the assessment of economic efficiency are used, taking into account the influence of financial, production and technological risks. The high level of the fluctuations of social, political, economic and technological impacts of the intercountry level has a strong impact on the result of their production activities. The peculiarities of this influence include the emergence of new institutions of interaction between the subjects of a cluster, the growth of uncertainty within the system and a change in the level of specificity of the assets of its participants. The task to find new tools for the assessment of the potential of economic security of a cluster is becoming urgent. It is necessary to find such tools which would take into account the ability to adapt to technological and geopolitical challenges in the future. Within the framework of this study, the authors developed an algorithm for the assessment of the potential of alternative models of the organizational structure of a high-tech cluster. The important methodological aspect of the process of forecasting the level of adaptability of alternative cluster structures to external changes is the condition for the availability of institutional support to promising areas of technical development. The developed algorithm presupposes the further development of the methods of system analysis and the formation of Institutional Atlases for the parameters of the assessment of the opportunistic behavior risks of subjects or synergistic effects. The use of this algorithm allowed drawing some important intermediate conclusions about the unequal composition and the influence of dominant institutional factors in modeling different organizational structures of a high-tech cluster.

1 Introduction

Cluster innovation structures are a considerably young subject for research in economics. The implementation of the sustainable development paradigm has a comprehensive impact on the formation of innovative clusters. It presupposes a flexible and deep transformation of technological development directions taking into account the global tendencies of the enhancement of environmental standards, post-crisis trends towards economic stabilization, the complication of the principles of constructing managerial tasks and special integral cultural values.

The relevance of the research topic is in the fact that in order to form breakthrough innovative technologies that determine the vector of scientific and technological progress, it is necessary to build such models of interrelations that would have the maximum potential for the implementation of the set goals, taking into account the factors formed by the general paradigm of the development of the country. The purpose of the study is to develop an algorithm for the assessment of the potential for the implementation of the paradigm of sustainable development in the process of modeling alternative organizational schemes of high-tech clusters.

The object of the research is the system of interconnections, management institutions and interests of subjects in the organizational model of a high-tech

cluster. The subject of the research is the process of the assessment of the level of cluster adaptability to the conditions of the implementation of the paradigm of sustainable development.

2 Research methods

The main problem during the choice of an adequate system of indicators for the assessment of the performance of a cluster is the need to form such a metric system, which will reflect the main strategic guidelines for the development of the country and the region in scientific, technical and technological breakthroughs providing environmental and economic security. Unfortunately, the appearing disagreements associated with the risks of the changes in the geopolitical goals of strategic development [1, 2], crisis phenomena and structural changes in economy [3], the emergence of new determinants of economic growth [4] and technical and technological requirements for entities implementing the concept of Industry 4.0. [5, 6] are mainly conceptual in nature and not always clearly parameterized. The process of formalization of the parameters is complicated by a number of specific properties of the object of research itself: firstly, each high-tech and innovative cluster is a unique institution in terms of its functional and competence composition.

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The result of the activity may affect some separate target task of a scientific and technical nature [7] or a complex one related to the strategy of smart specialization [8]. Secondly, the strategic goal-setting of clusters should be focused on comprehensive indicators of regional development [9, 10]. Thirdly, the proposed methods, which are most adequate for the task of modeling cluster structures [11, 12, 13, 14] are focused on the target indicators of industries and do not take into account the potential of the “best practices” of the subjects of a cluster. One of the concepts that most fully reflect the relationship between the indicators of the development of the regional level of management and the parameters of the formation of the competitive advantages of an enterprise is the concept of EFQM [15, 16, 17].

3 Research results

The task of modeling the structure of high-tech cluster institution with a high potential for the implementation of strategic goals is associated with the assessment of the possibility to adapt such a system to the emerging factors of the paradigm of sustainable development and “smart” economic growth.

In order to implement the algorithm, it is necessary to simulate alternative options for the production and supply structures of a cluster. Further, the assessment is carried out according to the following algorithm:

At the first stage of the algorithm:

1. An array of assessment indicators for each designed structure is formed;
2. The process of bringing the assessment indicators to a single parameterization system is carried out, the array of reduced indicators $\{q_{ij}\}$ is formed, where i is the number of the model, j is the number of the indicator;
3. A preliminary integral estimate for each cluster model without taking into account the influencing factors S_{ij} is formed;

At the second stage of the algorithm:

4. The principle of the assessment of the compliance of indicators with economic institutions of safety is formed determining their value in the process of production and marketing activities. To do this, we introduce In_{ij} indicator, which includes the number and value of the institutions used in the value chain:

$$In_{ij} \quad i=\overline{1, m}; j=\overline{1, k}, \quad (1)$$

where k - is the number of institutions in accordance with the composition of the institutional atlas (in a cluster industrial structure, it was 53 institutions [18,19]);

5. The transformation of the array of indicators by the value of the composition and value of institutions will be made according to the following formula:

$$q_{ij} = S_{ij} NI_{ij} \times In_{ij}$$

$$NI_{ij} = \begin{cases} 1 \\ 0 \end{cases}, \quad (2)$$

where NI_{ij} - the presence of an institution in the provision of the parameter q_{ij} (this indicator is an expert assessment of 0 or 1)

The third stage of the algorithm includes two tasks:

5. The formation of an approach to assess the level of adaptability of indicators to the strength of the influence of external factors of the institutional environment for each parameter relative to the maximum possible potential level of influence for each model:

$$KO_{ij} = \frac{S_{ij}}{S_{ijmax}} \quad \text{no } j = \overline{1,16} \quad (3)$$

6. The integral assessment of the potential of each organizational model, taking into account the influence of factors of the external and internal environment of a cluster:

$$QI_i = q_{ij} \times KO_{ij} \quad (4)$$

7. The assessment of the level of the model potential based on the comparison of integral estimates with and without the influence of external and internal institutional factors according to the following formula:

$$\Delta_i = Q_{mi} - QI_i \quad (5)$$

Table 1. Results of the relative point assessment of the characteristics of institutions

Assessment characteristics of institutions Q_{ij}	M 1	M 2	M 3
Set block of indicators			
1. Growth in research and development and other projects	85	100	37
2. Growth in the volume of investment costs of organizations	38	100	32
3. Growth in output per employee of an organization	30	68	100
4. Growth in the volume of innovative products shipped by organizations	13	100	75
5. Growth in the total revenue of organizations	71	79	100
6. Growth in the number of small innovative enterprises	75	60	100
7. Growth in the number of patented organizations - participants in the results of intellectual activity	100	68	96
Match block of indicators			
1. Leadership	61	71	51
2. Staff	61	71	51
3. Strategy	51	61	61
4. Partnership and resources	61	61	61
5. Processes, production, services	61	71	41
6. Results for staff	51	71	51
7. Results for consumers	51	51	41
8. Results for society	51	51	41
9. Business results	61	71	51
Total Q_{ij}	920	1154	989

The developed algorithm was tested on the problem of modeling three systems:

Model 1 – the implementation of a value-added system in the format of an innovation cluster,

Model 2 - a system of implementation in the format of a technological cluster

Model 3 - in the format of a strategically formed production cluster, taking into account innovative formations of business processes.

As a result of the quantification of the initial data formed on the basis of the expert report of the Consulting Company using the EFQM model, a table of basic values was created (Table 1)

The expert assessments of the importance of an institution in the process of the implementation of models in the formation and support of Q_{ij} indicators were carried out on a 5-score scale and are presented in Table 2.

Table 2. Institutional Score for the Basic Institutional Atlas

№	Institution	M1	M2	M3
Management institutions				
1	Institute for Industrial Policy	5	5	5
2	Institute of Foreign Economic Activity	0	5	1
3	Institute of Priority Areas	4	5	4
4	Self-government institute	5	4	4
5	Institute for Development Programs	4	5	5
6	Security Institute	5	5	5
7	Institute of guarantees	4	5	5
8	Institute of income	5	2	2
9	Institute of Management	0	5	5
10	Responsibility Institute	5	5	5
11	Institute of production activities	5	5	5
12	Institute for Strategic Planning	4	5	5
13	Activity Control Institute	1	5	4
14	Institute for Examination of Scientific and Technical Projects	1	5	5
15	Institute for Intercompany Planning	5	5	5
16	Institute for the organization of production activities	5	5	5
17	Institute for the organization of information activities	5	5	5
18	Institute of material incentives for activities	4	2	2
19	Institute for non-material incentives for activities	4	5	5
20	Institute of Technology	5	5	5
21	Business Consulting Institute	1	5	4
22	Institute for Research Activities	2	4	5
23	Institute for design development	5	5	5
24	Trial Production Institute	5	3	1
25	Customer Service Institute	4	3	1
26	Legal Defense Institute	5	5	5
27	Public welfare institute	4	3	5
28	Institute of Club Benefits	2	5	3
Institutions of Resource Use				
29	Institute for the Application of Information Resources	3	4	5
30	Institute for the Application of Intangible Assets	2	5	5

31	Institute for the Application of Material Resources	5	3	2
32	Institute for the Application of Labor Resources	5	5	5
33	Institute for the Application of Financial Resources	5	4	4
34	Institute for Licensing and Certification	5	4	4
Institute of interaction				
35	Institute of contractual relations	3	5	4
36	Institute of state orders	5	5	5
37	Counterparty Search Institute	5	2	2
38	Institute for Communication Activities	4	4	4
39	Institute for the Integration of Science and Business	3	4	5
40	Institute of Informal Relations	4	5	3
41	Benefit transfer institute	3	5	4
42	Institute for interaction organization choice	5	5	3
43	Institute of inter-firm cooperation	5	5	3
44	Institute of Transport and Logistics Systems	5	5	3
45	Transfer Price Institute	1	5	3
Institutions of external influence				
46	Market Institute	5	2	2
47	Institute of Currency and Export Control	1	5	1
48	Institute of Taxation	3	3	3
49	Property Institute	5	3	3
50	Institute of Education	3	5	5
51	Technology Transfer Institute	3	5	5
52	Institute for Diffusion of Innovation	3	5	5
53	Institute for the formation of added value	1	5	3
Total		196	234	207

The maximum number of points for all institutions is 265 points, therefore, if the model receives:

1) 0-88 points then the influence of institutions is insignificant

2) 88-176 points, then the level of influence of institutions is average

3) 176-265 points then the level of influence of institutions is high

Then, according to the developed algorithm, the assessment was carried out and the composition of institutions that directly affected the implementation of indicators was assessed.

4. Results and discussion

The obtained values of assessment are shown in Table 3 and indicate a positive deviation of the integral indicator in all models. This means a more significant impact of the institutional environment of a cluster on the activities of the enterprises included in it in comparison with expert

assessments of risks incorporated in the socio-economic assessment of each project.

Thus, the values of the deviations make it possible to talk about the high level of the institutional potential of the second model, but the presence of a large number of institutions forms a high uncertainty in the effectiveness of links between business processes. Model No. 1 can be characterized as a low level of uncertainty and a high degree of elaboration of new innovative mechanisms of interactions.

Table 3. Assessment of the model potential of production and supply system of high-tech cluster

Models of production and supply system	Q _i	Q _i	Δ
Model 1	934,17	920	14,19
Model 2	1 364,13	1 154	210,40
Model 3	1 081,20	989	92,09

Model No. 3 demonstrates a high level of potential, despite the fact that it is based on the business processes of an industrial cluster. The introduction of new technologies of remote access in business processes leads to a slightly higher level of risks (compared to Model No. 1).

In conclusion, it is necessary to note the importance of the focus on the processes of mutual influence of the factors of the global paradigm of sustainable development and the parameters for the assessment of the potential of high-tech clusters. The introduction of innovative forms of business processes for remote access to data, the commercialization of projects through the structures of technologic and industrial clusters will help national enterprises to take a leading position at the global market of high-tech products.

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