

## Situation modeling of interaction between enterprises of the region and cross-border industrial clusters

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**Abstract.** The article describes the background of development of the cluster forms of interaction between Ukrainian industrial enterprises; models of interaction of large and small businesses are considered, different situations of the "cluster and outsourcer" relationships are identified by weighted index of the interaction potential.

**Key words:** enterprise, cross-border industrial cluster, situation modeling, region, interaction.

### PROBLEM

Ukraine has a favorable geostrategic position in the center of Europe, focusing on its territory important transportation lines, international shipping routes. In the general concept of innovative development, developed by the European Commission in connection with the expansion of the EU priority directions of the state policy in the field of economic development based on innovation and knowledge are determined. Serious attention in it is paid to the creation, primarily at the regional level, of specialized organizations of supporting innovations - technology parks, business incubators, technology centers, cluster associations.

In September 2008 Ministry of Economics of Ukraine developed a Concept of creating clustering in Ukraine. The aim of this Concept is identification of the general principles of creation, functioning and development of clusters, as industrial structures of a new breed, in contrast to associations, corporations, consortia, corporations, the theory and practice of creation of which Ukraine has passed during the planned economy.

The limitation and in some cases lack of possibilities of reconstruction of the production capacity of domestic industrial enterprises make this process in

Ukraine more complex. In these circumstances, a strategy for the development of their participation in cross-border industrial clusters may be quite effective.

### ANALYSIS OF PREVIOUS RESEARCH

Generally speaking cross-border clusters can be defined as a network of manufacturers, suppliers, consumers and other elements of industrial infrastructure of two or more countries interdependent in creating added value.

Before the advent of the term "cluster" in the economic literature it has been used in other fields of science (chemistry, astronomy, physics, etc.). However, although this term has found its rightful place in the economic literature only in the last decade of the twentieth century, industrial complexes (i. e., classical clusters) took an important place in the research of economists during all the period of the existence of modern economics.

You should consider the development of industrial clusters as a long process that started in the period of a rise of industrial capitalism at the end of the 19th century. In the monograph from the history of the industrial capitalism A. Chandler [1] draws attention to three main factors of growth of modern companies in the leading industrialized countries, the U.S.A., Germany and the UK. These three factors, the benefits from scale, the benefits from the size and savings due to reducing transaction costs have been constantly changing as a result of the development of new technologies, increase of the market, and also changes in government and public institutions of states. The ability to take advantage of these three factors in order to reduce costs has invariably led businessmen to success.

The most important place in the development of a theoretical base of branch clusters is given to "theory of the firm", proposed by R. Coase [2] as well as to the works of Schumpeter [3] about the dynamics of competition, which appeared at the same time that the new interpretation of Marshall's theory about industrial regions proposed by P. Krugman appeared. [4] These and other economists have created the foundation for the new institutional economics by developing a model that explains the reasons for the formation of economic clusters at different levels.

The new explosion of interest of experts in industrial clusters was caused by the publication in 1990 of the work of the professor of Harvard University M. Porter "Competitive advantages of countries" in which he proposed the theory of national competitiveness. [5] In this theory, the leading role is given to clusters.

According to E. Bergman [6], the biggest contribution of Porter to the theory of cluster development is a combination of the theory of international competition and strategic research related to the search of clusters, the economic activity of which arouses interest and willingness to cooperate with companies from other countries. This connection allows you to extend the concept of the classical cluster far beyond the limits of geographically localized industrial complexes.

One of the phenomena that are closely linked to globalization is the transnationalization - the development of large international corporations that carry out their activity all over the world. Until today there is no generally accepted term for the definition of such associations. In the literature, terms such as "integrated corporate structure" [7], "a connected diversified system" [8], "an integrated business group" [9], as well as "metacorporation" [10] are used.

A modern economic theory sets a more complex and integrated value to an industrial cluster. In the works of P. Doeringer, J. Terkle, S. Rosenfield, M. Enright and others clusters are discussed in the context of competition theory, according to which they are transformed into corporate entities of inter-industry orientation, able to accelerate the process of integration of national economies into the world economy significantly. A cluster approach in its new interpretation is based on understanding that the industrial complexes of two or more countries can get an important competitive advantage in conditions of a globalization by creating a cross-border cluster [11]. Innovation processes in the modern world are not related to the activities of individual firms or industrial complexes, but allow the creation of cluster networks with a high level of direct and backward economic and technological links. [12] In other words, innovation activity of industrial complexes is more and more dependent on how they are able to use and adapt the experience of similar complexes, and also create cross-border clusters.

## PRESENTATION OF THE BASIC MATERIAL

One of types of cluster interaction is the cooperation between large and small business. Such forms of involvement of small businesses in the operating cycle as the supply of spare parts, maintenance works, if necessary - improvement of the developmental prototype and utilization of production after completion of useful lifetime are referred to this type of cooperation (Table 1).

Clusters take different forms depending on their complexity, but they usually involve companies with a finished product, service companies, suppliers of specialized goods and services, financial institutions, firms with developed sales channels and customers.

Within the cluster, there are vertical (buyer - supplier) and horizontal (common customers, technologies, intermediaries) links through which the interaction of different intensity is carried out. Links between enterprises are carried out by passing different flows (information, money, goods, etc.) via the cluster's channels. These links can be determined by analyzing the intensity of the use of different channels within the cluster. Rare use of some channel between companies in a definite time indicates a weak link of enterprises in this flow, and frequent use indicates power of the channel that connects them.

Flows providing normal development of the product creation process within the cluster are: money, labor, information, the flow of finished and semi-finished products, material and intellectual. The evaluation of these flows for a new enterprise (enterprise that wants to join the cluster) is a decisive factor determining the basic direction of organization of interaction with the cluster.

In order to make an analysis of the interaction between a new company and the cluster it is advisable to use the method of evaluation of the interest of a cluster and a new company to determine direction of development strategy based on the strengthening of the existing benefits.

The first step in the procedure is the evaluation of the attractiveness of the cluster for a new company, and then evaluation of the attractiveness of a new company for a cluster from the point of supply and demand for resources available to them. A new company has access to a particular flow in the environment, has some certain resources with a help of which it produces certain kinds of products. A cluster is interested in the resources and products produced by a new company in the process of interaction and a new company has access to other flows of a cluster that are of its interest. The interaction process lies in the exchange of one resource to another, or in the purchase of this product or a substitute.

Before cooperation a new company determines resources, products, which it will send to the cluster, and, in its turn, will have access to the flows of the cluster. You can determine the interest of other enterprises of the cluster in cooperation with the new enterprise through the estimation of the new company's flows, which will be included in the cluster (Table 2).

**Table 1.** Models of cooperation of big and small enterprises in the process of innovative cluster-based interaction <sup>1</sup>

Type of the subject of cluster-based interaction	Small enterprises	Cluster	Big enterprises
Field of interaction	Production	Realization	Non-productive cooperation
Forms of interaction	Investment of a big enterprise	A small enterprise realizes production of a big enterprise	maintenance works, improvement of a developmental prototype
	Developments of a small enterprise	Using a trade mark of a big enterprise	Utilization after completion of useful lifetime
	combined participation in production	A big enterprise realizes production of a small enterprise	Mobilization of uncommitted resources
	Manufacture and release of a developmental prototype for manufacture	Marketing measures	Solution of social and domestic questions

**Table 2.** Being in demand for resources at a new enterprise <sup>2</sup>

Flows	Number of products, G	Number of accesses, A	R <sub>bi</sub>
Money	G <sub>1</sub>	A <sub>1</sub>	R <sub>b1</sub>
Labour resources	G <sub>2</sub>	A <sub>2</sub>	R <sub>b2</sub>
Information	G <sub>3</sub>	A <sub>3</sub>	R <sub>b3</sub>
Raw materials and materials	G <sub>4</sub>	A <sub>4</sub>	R <sub>b4</sub>
Equipment	G <sub>5</sub>	A <sub>5</sub>	R <sub>b5</sub>
intellectual assets (knowledge)	G <sub>6</sub>	A <sub>6</sub>	R <sub>b6</sub>

**Table 3.** Classification of backgrounds of cooperation between an enterprise and a cluster according to a criterion of weighted index of interaction potential <sup>3</sup>

Code of situation	Direct estimation									Weighted estimation						Type of situation
	Demand for resource of a cluster, Idbi	Supply of resource by an enterprise, Isbi	Demand for resource of an enterprise, Idci	Supply of resource by a cluster, Isci	Balance	Prospects of interaction	Level of prospects of interaction	Index of prospects of interaction	Type of situation	Demand for resource of a cluster, Idbi	Supply of resource by an enterprise, Isbi	Demand for resource of an enterprise, Idci	Supply of resource by a cluster, Isci	Level of prospects of interaction	Index of prospects of interaction	
1111	1	1	1	1	1	2	4	1,00	A	1	1	1,4	1	2,4	1,0	A
0111	0	1	1	1	0	1	1	0,25	C	0,4	1	1,4	1	1,8	0,8	B
0110	0	1	1	0	1	1	2	0,50	B	0,4	1	1,4	0	1,4	0,6	C
1110	1	1	1	0	0	1	1	0,25	C	1	1	1,4	0	1,4	0,6	
1001	1	0	0	1	1	1	2	0,50	B	1	0	0	1	1	0,4	D
1011	1	0	1	1	0	1	1	0,25	C	1	0	1,4	1	1	0,4	
1101	1	1	0	1	0	1	1	0,25	C	1	1	0	1	1	0,4	
0001	0	0	0	1	0	0	0	0,00	D	0,4	0	0	1	0,4	0,2	E
0011	0	0	1	1	0	0	0	0,00	D	0,4	0	1,4	1	0,4	0,2	
0101	0	1	0	1	0	0	0	0,00	D	0,4	1	0	1	0,4	0,2	
0000	0	0	0	0	1	0	0	0,00	D	0,4	0	0	0	0	0,0	F
0010	0	0	1	0	0	0	0	0,00	D	0,4	0	1,4	0	0	0,0	
0100	0	1	0	0	0	0	0	0,00	D	0,4	1	0	0	0	0,0	
1000	1	0	0	0	0	0	0	0,00	D	1	0	0	0	0	0,0	
1010	1	0	1	0	0	0	0	0,00	D	1	0	1,4	0	0	0,0	
1100	1	1	0	0	0	0	0	0,00	D	1	1	0	0	0	0,0	

<sup>1</sup> Developed by authors.<sup>2</sup> Developed by authors.<sup>3</sup> Developed by authors.

$G_i$  – number of products, goods, services, produced by a new enterprise using an  $i$ -th resource for the period ( $i=1, \dots, 6$ ).

$A_i$  – number of accesses of a new enterprise to  $i$ -th flow in the process of products producing for the period ( $i=1, \dots, 6$ ).

$R_{bi}$  – indicator characterizing a being in demand for  $i$ -th resource at a new enterprise while producing products ( $i=1, \dots, 6$ ):

$$R_{bi} = G_i / A_i. \quad (1)$$

You can make an estimation of interest of a new enterprise in joining a cluster, focusing on the value of ranks determined in such a way. You can say that there is favorable for the future prospects level of demand of an enterprise for cluster resources and demand of a cluster for resources proving by an enterprise at higher values of the corresponding ranks, which would indicate an interest of a new enterprise in cooperation taking into account the demands of the new enterprise for cluster resources and taking into account offers of these resources by a cluster.

Mathematically, this will be expressed in assigning a value equal to one (in the opposite case - 0) to indexes of demand of an enterprise for cluster resources ( $I_{dbi}$ ), demand of a cluster for resources proposed by an enterprise ( $I_{dci}$ ), supply of the appropriate resource by a cluster ( $I_{sci}$ ) and supply of it by an enterprise ( $I_{sbi}$ ). As a result a base of a situational model of interaction strategy of the enterprise and the cluster on the basis of combinations of values of the chosen parameters is formed. The first step in the process of formation of such a model is the classification of typical situations. Based on the four obtained values of the variables of parameters and under conditions when one of two values (+/ -, 1/0) can be assigned to each of the variables of parameters, it is more reasonable to use a binary codification (Table 3).

The basis for the classification of situations is the index of the interaction potential, defined as the relative potential of interaction, which in its turn is defined as the sum of the product of indicators of the reciprocal supply and demand for the resources on the part of the enterprise and the cluster:

$$IP_i = (I_{dbi} * I_{sci} + I_{sbi} * I_{dci}) / P_{i_{max}}. \quad (2)$$

Depending on the parameters' values that determine it, an index of interaction potential can range from 0 to 1. Based on the values of this indicator four situations can be distinguished to which the appropriate literal notations have been assigned (Table 3, direct estimation). Based on the obtained results the participants can select potential areas for development strategy or adjust existing ones at the moment. The situations of groups A and B can be considered as the most promising from the standpoint of interaction potential.

Obtained in this way typology to a certain extent allows to get a foretaste of the prospects of cooperation

between industrial enterprises and the cluster. However, you should not consider the received typology to be satisfactory due to two reasons. Firstly, situations where the supply and demand of the enterprise and cluster are unbalanced but positive (0001, 0011, 0101) will not be considered as promising at the application of this approach. Obviously, there is a cause and effect link between supply and demand, which creates a potential for the development of the situation in the direction of a formation of cluster interaction. Such a scenario is not required, however, and the presence of a specific interaction potential cannot be denied.

Secondly, at using this approach situations where supply and demand in the system "enterprise-cluster" are well-balanced, will be considered relatively more promising while the total potential of this interaction is relatively lower: for example, situation 1001 will be considered as a more promising, when there is a balance between supply and demand, although it is obvious that the situation 0111, when the supply of cluster resources is faced with lack of interest of the enterprise to it so far, is more promising. Consequently, a need for modification of the index of interaction potential for the purpose of taking into account indicated disadvantages has emerged.

Modification was performed by weighting indicators included in the index. The greater weight is assigned to values  $I_{dbi}$  and  $I_{dci}$ , reflecting the demand for resources offered by a cluster on the part of the enterprise and demand of a cluster for enterprise's resources accordingly. This operation a) takes into account the leading and decisive role of demand in relation to the supply, b) reflects a relatively big potential forming role of the demand, c) reflects the relatively higher development potential of situations characterized by imbalance of supply and demand, and d) takes into account the leading role of the cluster in the formation of interaction potential:

$$I_{dbi} = \begin{cases} =1 & \text{at presence of} \\ & \text{demand and} \\ =0,4 & \text{at its diagnosable} \\ & \text{absence} \end{cases},$$

$$I_{dci} = \begin{cases} =1,4 & \text{at presence of} \\ & \text{demand and} \\ =0 & \text{at its diagnosable} \\ & \text{absence} \end{cases}.$$

A classification of situations, received on the basis of the value of weighted index of the interaction potential allows distinguishing a bigger number of possible situations, to each of which a literal notation is assigned.

Groups A ( $IP_i = 1$ ), which reflects the balance of supply and demand on the  $i$ -th resource, and B ( $IP_i = 0,8$ ) are the most favorable from the point of view of the development of the cluster interaction. A new company

can quite simply find its place among the enterprises of the cluster and  $i$ -th resource brought with it, is in demand in the cluster. The cluster has the  $i$ -th resource at its disposal, and the diagnosable absence of a demand for this resource on the part of the new enterprise may indicate an insufficient level of awareness of the synergistic potential of interaction with the cluster on the part of the latter.

Group C ( $IP_i = 0,6$ ) is characterized by a mutual interest of a new company and a cluster with a limited supply of resources on the part of the latter. This situation has a still high, but relatively less potential for development, as occurrence of such situations is typical for the period of the formation of the cluster and inconclusive formedness of the system of relations within it. Under certain conditions, this interaction is beneficial and sufficient.

In situations of group D ( $IP_i = 0,4$  supply and demand are close to balanced: there is a demand on the part of an enterprise and supply of the appropriate resource by a cluster. Regardless of the interest of the cluster in the resource proposed by an enterprise a situation is characterized by the presence of the interaction potential. Under real conditions a cluster and an enterprise favorably interacting on the  $i$ -th resource most often find themselves in a situation of this group.

Situations of group E ( $IP_i = 0,2$ ) are characterized by a willingness of a cluster to cooperate and a diagnosable lack of interest on the part of the company. A favorable interaction of a cluster and a new enterprise in this case is possible, but a favorable result will depend on the willingness of the participants (in the first place - companies) to make concessions and be adaptive under the conditions of limited supply and demand.

In situations, referred to a group F ( $IP_i = 0$ ) a lost interest of counterparties, is observed, expressed in the absence of flow of a required intensity level of the  $i$ -th resource in a cluster or in a new enterprise. Possible to say that there is a mismatch of supply and demand of the  $i$ -th resource in the cluster or a new enterprise. A new enterprise or cluster should review their capabilities and requirements, as it is more reasonable in a given situation to look for a new partner on retention of the current condition.

## CONCLUSIONS

Thus, in the article it is shown that the participation of industrial enterprises in the cluster interaction is one of the almost mandatory conditions for increasing com-

petitiveness of the region and the country as a whole. Under conditions when economic agents, formerly included in one economic complex are separated by national borders, the only possible form of effective cooperation is the creation of transnational industrial clusters. Within the framework of this article the results of situation modeling of backgrounds of interaction between an enterprise and an industrial cluster based on the chosen criterion of the index value of the interaction potential, which reflects the mutual supply and demand for different types of resources used at creation of the final product on the part of a cluster and an enterprise - counterparty are disclosed.

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