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Innovative Forms of Production Organization in the Context of High-tech Meso-economic Systems Sustainable Development

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ABSTRACT

The article's objectives involve the models' development to stimulate joint innovation activities of enterprises of chemistry and technology of polymeric and composite materials based on new forms of co-competition relationships. The leading method to the problem study is a simulation method that allows this issue's consideration as a focused and organized process to improve the innovative development management of industrial enterprises of chemistry and technology of polymeric and composite materials based on the co-competition model. The article suggests the co-competition classification, which is adequate to various types of innovative projects; a set of recommendations on the appropriateness of co-competition models' choice for enterprises of chemistry and technology of polymeric and composite materials is scientifically justified. The practical value is that the developed techniques allow at a greater expense and more concretely to regulate innovative activity of enterprises through the co-competition models' use and can be used in the framework of industrial programs.

Keywords: Co-competition, Clusters, Chemistry and Technology, Sustainable Development, Innovative Elevator
JEL Classifications: Q01, Q43, Q32, R11

1. INTRODUCTION

1.1. The Relevance of the Study

The modern economy is characterized by a huge expenditure of energy, capital and labor to maintain the competitive advantage of industry at the appropriate level, i.e., escalating the pace and scale of production due to the increasing use of limited natural resources. This development not only endangers the security of industrial production, but also can make it impossible for future generations to meet their needs (Gumerov et al., 2016a; 2016b; Kharisova et al., 2015; Malysheva et al., 2016; Drozdova, 2014; Drozdova and Lyapuntsova, 2015; Sabirov et al., 2015). In order to ensure greater stability of industrial sectors we need to have the tools to assess the reliability of their work. In this connection, works are noteworthy (Williamson, 1985; Silverberg and Verspagen, 1995; Kleiner, 2006; Lazonick, 2006; Shinkevich and Shinkevich, 2011; Krugman and Venabies, 1995; Mensch, 1979). Hence, there is a need to systematize the criteria and methods for production reliability assessing in various sectors of the economy.

In addition, the economic development of the high-technological meso-economic systems based on the production consolidation, strengthening of the market power and scale's effect implementation, has limitations as a weakening of innovations' incentives particularly due to market mechanisms' violation because of the lower intensity of competition and the market monopolization' s increasing trends.

Therefore, there is an interest in the study of organizational forms of competition which, enhancing the enterprises' economic

potential in the market, lead to negative manifestations' avoiding of large enterprises' market power. Such a phenomenon may be "co-competition," which can be considered the actual reserve of innovation development at the industrial and regional levels.

2. METHODOLOGICAL FRAMEWORK

2.1. Theoretical Base of the Study

The theoretical basis of the article are control theory, theory of innovations, neo-institutional theory, evolutionary theory of innovation changes, cyclical theory of innovative development, the theory of transaction costs, the theory of the effectiveness of economic phenomena and processes. The objectives of the study are: Development of a method of reliability assessment of production's high-technological meso-economic systems based on the Balanced Scorecard, in accordance with the sustainable development's concept; the development of cross-industry collaboration models to stimulate innovation activities of enterprises based on new forms of co-competition relations.

2.2. The Research Methods

For research results' obtaining general scientific and private methods of knowledge cognition were used: The method of formalization, the dialectical method, analogies' method, analysis and synthesis, methods of system, structural-functional, economic and mathematical modeling, imitational simulation, multi-faceted statistical analysis, comparison, the index methods, matrix methods, methods of forecasting.

2.3. The Research Stages

The study includes three stages:

- At the first phase the sustainable development of enterprises of chemistry and technology of polymeric and composite materials was assessed.
- At the second stage the economic essence of co-competition models was determined.
- At the third phase the testing of innovative forms of production's organization in the context of sustainable development of high-technological meso-economic systems was conducted.

3. RESULTS

3.1. Sustainable Development's Evaluation of Enterprises of Chemistry and Technology of Polymer and Composite Materials

Organization of Chemical Engineers (Institution of Chemical Engineering) considers the sustainable development as the most significant challenging issues currently facing humanity. It is necessary to consider a method that can be used to measure the characteristics of the enterprise's current stability in the whole or a unit of production and economic organization.

On the basis of the need to incorporate all three components, the level of stability is offered to estimate using the corresponding indicator (*In*), which is calculated as the sum of indicators of the three dimensions: Economic (*Iecon*), environmental (*Iecol*) and social (*Ic*) with corresponding weights coefficients.

Indicators *Iecon*, *Iecol, Ic* are derived from the values of the other parameters and, respectively, are calculated as the aggregated indicators (AI).

Indicators have different dimensions, so when calculating the aggregate indicator moving to the comparable dimensionless variables - Normalized indicators is carried out.

The valuation is carried out by the following way. For each *j-th* indicator maximum and minimum value is selected, with a maximum value of *M* equal to 1, and the minimum value of *m* - to 0. Let *T* - be current value of the index, then the (Formula 1):

$$I_j = \frac{T - m}{M - m} \quad (1)$$

For the record, in which there is an inverse relationship, i.e., the minimum value of the index is the best one, the score is calculated by the following way (Formula 2):

$$I_j = 1 - \frac{T - m}{M - m} \quad (2)$$

The weighting factors determine the degree of indicator's preference used in calculating of the aggregate indicator, for which any system of points can be used (in this technique a 3-point system of weights is used). Most priority indicator (indicators) has 3 points, others -depending on the remaining priority - 2 or 1. From the values of the weighting coefficients on the point system moving to the relative weights is carried out, which are calculated in such a way that their sum in calculating of the aggregate indicator was 1.

Relative weighting coefficient (K_i) is calculated by the following formula (Formula 3):

$$K_i = \frac{VB_i}{\sum_{i=1}^{n} VB_i} \quad (3)$$

Where VB_i - Indicator's weight coefficient according the point system

i - Indicator

n - Indicators' quantity

AI is a sum of terms of indicators standing at a lower level in the indicators' hierarchy and adjusted with the relative weighting coefficient. AI takes a value from 0 to 1 (Formula 4).

$$AII = \sum_{i=1}^{n} (I_i * K_i) \quad (4)$$

Where:

AII - Aggregated indicator

I_i- Normalized indicator

K_i - The relative weighting coefficient

n - The number of parameters involved in the formation of the AI.

This technique allows us to calculate the aggregate indicators - *Iecon*, *Iecol, Ic.* Therefore, *In* is the sum of indicators with appropriate weight coefficients (Formula 5):

$$In = Iecon*K_i + Iecol*K_i + Ic*K_i \quad (5)$$

Where:

In - Indicators of sustainable development

Iecon - Indicator of economic reliability of production

Ic - Indicator of social reliability of production

K_i - The relative weighting coefficient.

During the calculating of the integral indicator "Sustainable development of production" in accordance with the priority the used indexes were assigned the following weights: Economic reliability - 3 points, social and environmental reliability - 2 points.

In accordance with the proposed method the economic, environmental and social indices and, therefore, the index of sustainable development of chemistry and technology of polymeric and composite materials were calculated. The analysis showed that the greatest development sustainability belongs to the enterprise of chemistry and technology of polymeric and composite materials (integral indicator of the reliability of production for 2013 amounted to 0.58), which is due to the high values of economic, social and environmental indicators.

This method is a convenient tool for a more detailed assessment of sustainable development, which allows:

- Set priorities for the development sustainability level's improving in the enterprises of chemistry and technology of polymeric and composite materials.
- Carry out a review of approaches, principles, forms of economic policy, taking into account ecological and social parameters of development.
- Analyze the current level of reliability.
- Carry out levels comparison of development sustainability (including economic, social and environmental characteristics).

The next stage of sustainable development of enterprises of petrochemical complex is considered to be the introduction of co-competition models.

3.2. The Economic Essence of Co-competition Models

Economic development in the industrial sectors of the economy, which include chemistry and technology of polymeric and composite materials based on the consolidation of production, strengthening of the market power and scale effect implementation, has limitations as a weakening of innovations' incentives particularly due to market mechanisms' work violation after the competition intensity reduction because of market monopolization trends increasing (Shurkina et al., 2015). Therefore organizational forms of competition which, strengthening the economic potential of the enterprise in the market, contribute to negative manifestations' avoiding of large enterprises' market power are of special interest. Such phenomenon is believed to become "co-competition" - Date resource of innovative development at the industrial and regional levels (Shinkevich and Lubnina, 2011). The co-competition is offered to understand the implementation of innovative projects on the basis of the competitors' incentives emergency for co-production (the order of production) of an innovative product in the different phases of the life cycle of innovative product.

The content of the models and their organizational arrangements are described in detail in the following works (Shinkevich and Lubnina, 2009).

Developing this approach, we propose to consider the following examples of co-competition models: Model of technological co-competition - A strategy of shared profit sharing; model of market co-competition - The innovative elevator of university students model of indirect co-competition - cluster development.

3.3. An Example of the Technological Model of Co-competition "Strategy of Share Profit Sharing"

The essence of corporate strategy of chemical products' supply chain management is as follows: Suppliers of chemical products are imposed shared direct financial participation in profits from the efficiency improving of chemical products' using for the enterprise-chemical products' consumer.

This corporate strategy provides a key benefit in the management of the enterprise - A consumer of chemical products, including reduced operating costs and increased productivity, and greatly increases the environmental indicators of the enterprise-customer.

In practice, a large number of relationships can be selected in the supply chain. These relationships can be grouped into a hierarchy that consists of four levels:

- Share profit sharing
- Limited control
- Services
- Traditional supply relationships.

The payment system is a method that is used to reward the delivery of chemical products. There are the following payment systems:

1. "Dollar for Pound" - A traditional approach when products are bought by weight, gives rise to a business relationship in the supply chain, in which the dominant factor is the price of this product. By the supply increasing supplier receives a large profit.
2. "The dollar for pound plus services" - The consumer can pay a higher price, but he expects from a supplier added services. Supplier receives a large profit by providing better services and increasing of supply volume.
3. "Payment for the administration" - These provider's services are separated from the production cost, in order to prevent a supplier's commitment constantly to increase shipments of chemical products. The costs are transferred to the consumer,

and chemical products can be purchased from third-party suppliers.

4. "Shared profit sharing - Shared savings" - Chemical products' consumer is no longer acquiring chemical products as this one; instead of it, the supplier is paid fixed charges per month or per unit of output. Provider's profit is no longer connected with the volume of deliveries of chemical products. Reducing the amount of chemicals needed to the consumer, the suppliers reduce their costs and get more profit. In fact, the cost decline is converted into savings, distributed between a consumer and a supplier of chemical products.

At each level of the hierarchy of pay systems the reward that is paid to the suppliers, more and more is determined by the value of their services for the consumer, not by the volume of the products delivered.

On the basis of the strategy of shared profit sharing the main characteristics of the relationships with the supply chain management can be identified:

1. The consumer no longer buys a chemical product. Chemicals considered to be owned by the supplier until it is used in the production process for consumer enterprise.
2. Provider receives a fixed fee (per month or per unit of production) in return for performance of chemical products characteristics' (quality indicators).
3. Provider makes a profit at the expense of reductions in the use of chemical products and their costs, but not at the expense of sales of chemical products.
4. Provider provides management of chemical products at the place of its use, including the observance of labor protection requirements, enhanced logistics services and application services for the application of chemical products.

It should be noted that the ultimate goal of the shared profit sharing strategy using is not only the products' buying itself, but also the characteristics of these products.

Chemical products' management programs on the basis of the shared profit sharing strategy provide valuable benefits to both consumers and suppliers. Consumers benefit from lower costs and efficiency improving of chemical products' using. Cost reduction affects all the costs of activities related to the use of this product, including inventory, logistics, materials handling, waste disposal, etc. The range and volume of chemical products' using are reduced. Performance characteristics are increased not only of basic services, but also of main production processes.

3.4. An Example of Market Co-competition is an Innovative Elevator of University Students

Among the main reasons for the insufficient use of innovative potential of the Russian economy should be indicated such as an inadequate staffing of the high-tech industry. The shortage of highly qualified personnel manifests itself at all industrial enterprises. When training specialists in universities an important role belongs to professional adaptation of students, which is the process and the result of their adaptation to the demands of the occupation, assimilation of professional and social norms of behavior required to perform job functions related to the research and its subsequent commercialization. The most promising form of the objectives' achievement within the university is an innovative elevator.

Under the mechanism of students' innovative lift is understood a set of links in a single system for university for students' research, business plan's development and its project's implementation, performers' team forming and implementation at small innovative enterprises within the high schools (Shinkevich et al., 2013).

Professional adaptation of students starts from the first floor, with theoretical skills' obtaining corresponding to the selected profile of education and through participation in interdisciplinary courses for the specifics of the related specialties' mastering. It involves the simultaneous training of researchers, engineers, economists and managers. Therefore, at the first stage, students receive the necessary theoretical basis for the development of innovative projects. Students' theoretical training is provides by the teaching staff at the university departments in scientific and educational laboratories of the university.

The second floor of the innovation elevator involves undergraduate students' participation, starting from the third year, undergraduates', graduate students' participation, who is looking for innovative ideas and plan to work on them. Students Scientific and Technical Society - Research Work of Students in consolidation with faculties and departments hold different competitions, contests, conferences and job fairs on the base of KNRTU, as well as other universities of Tatarstan and the Russian Federation.

The third floor includes the development of practical skills how to convert technologies into marketable products, preparation of business plans and the development of the final commercial product, process or service based on a technical model. In addition, at this stage, the sources' search for projects' financing is carries out by submitting them to potential investors. Practical developments are conducted in the Engineering Center, established in KNRTU.

The fourth floor involves student's participation at the start of an experimental batch of innovative products' production. The integration of education and research activities with the university innovative system, namely the design and activity educational technology is carried out on the sites of innovation and university business incubators.

On the fifth floor an establishment of their own business, assembly of production line, production start-up, or further work taking into account the experience obtained take place. This stage provides for the students' inclusion in the business community at the regional level. With this purpose KNRTU closely works with small innovative enterprises, partner enterprises, attracting entrepreneurs and business entities to teaching, conducting of competitions of business plans and graduates' employment.

Thus, the implementation of students' innovation elevator mechanisms of KNRTU allows students to improve the process of adaptation to the demands of their occupation, assimilation of

professional and social norms of behavior required to perform job functions related to the research and commercialization of their results.

3.5. An Example of an Indirect Co-competition Model-Cluster Development

The economy of Tatarstan Republic is characterized by stable dynamic growth. However, it is clear that in the present conditions the potential of autonomous development has exhausted itself. The competition between companies, regions and countries and, most of all, competition for markets, financial resources, intellectual capacity and other information resources become sharp. The most effective tool for economic development is the use of cluster development technology.

Cluster - Is an association of interrelated and mutually complementary economic entities which are in a relationship of functional dependence in the production process and goods' sale (services).

The objective of cluster development of economic sectors and social sphere in the republic is to increase the competitiveness of the Tatarstan economy through modernization and diversification.

To achieve the stated purpose the following tasks should be fulfilled:

- The formation of the economic ground of the cluster based on the evaluation of the economic potential of business entities related to the technological chain.
- Creating of legal framework for the formation and development of clusters.
- Creating of conditions for the effective development of clusters, including the development of strategies for their development ensuring competitive advantage of cluster entities.
- Harmonization of the establishment and operation of industry (sector) clusters and their educational, scientific and methodological support.

According to the Ministry of Industry and Trade of the Republic Tatarstan and the Ministry of Economy of the Republic Tatarstan the oil and gas chemical cluster of the Republic Tatarstan includes 59 companies. In the oil and gas chemical cluster of the republic falls (from the level of 2014):

1. 42% of the added value of the Republic Tatarstan
2. 51% of shipped goods of own production
3. 78% of the exports of the republic
4. 19% of the total investment in fixed assets
5. 6% of the working population.

The forms of measures' implementation by of state support for cluster development are:

- Creation of nationwide monitoring system, information and methodological support of clusters' development (creation of forms of state statistical reporting, including the calculation of the coefficient of localization for the evaluation of the contribution of each company in the activities of the cluster)
- The development of the legal and regulatory framework to ensure the establishment and functioning of clusters (with the circuit outlining of enterprises in the cluster)
- The provision of preferences under the existing legislation
- Proactive preparation of industrial sites for the development of the cluster
- Staff training and retraining for the cluster entities
- Promotion in the introduction of modern enterprise, production and process management systems.

Development of cooperation between suppliers and manufacturers is one of the short-term prospects for the development of cluster systems in the Republic Tatarstan, as well as a tool for achieving of long-term prospects in innovation and technological production enhancing.

4. DISCUSSIONS

To the Investigation of innovative development models of countries, regions and individual enterprises a significant number of fundamental and applied research works are devoted (Leydesdorff, 2005; Lazonick, 2006; Mensch, 1979; Perez, 1985; Silverberg and Verspagen, 1995; Krugman and Venabies, 1995). Some of them are based on the provisions of neo-institutional theory (Nelson and Winter, 1982; Shinkevich, 2005; Williamson, 1985). Considerable research interest belongs to the development of methodological approaches in the assessing of the institutionalization effectiveness and management of the sustainable innovation development. There are fragmented research and tasks' setting by economists, which can be adapted to solve the scientific problem. They include findings and research results (Wallerstein, 1979; Williamson, 1985; Polterovich and Popov, 2007; Tatarkin and Romanova, 2008; Katkalo, 2003). The relatively small number of publications are devoted to the study of competition forms and cooperation in R and D sector (Brandenburger and Nalebuff, 1996; Moore, 1996; Shinkevich and Lubnina, 2009).

However, at the presence of extensive theoretical and methodological data and practical solutions there is no a unified methodology to measure sustainable innovation development and formalized quantitative approaches that combine the latest achievements of modern management science and reflecting the significance of their specifics.

5. CONCLUSION

The method of assessment of the reliability of the production of high-meso-economic systems based on the Balanced Scorecard, in accordance with the concept of sustainable development is suggested.

The economic content of the category "co-competition," under which it is proposed to understand the implementation of innovative projects on the basis of competitors incentives' emergence for co-production (the order of production) of an innovative product in the different phases of the life cycle of product innovation is clarified. The classification of types of co-competition, adequate to various types of innovative projects

is given. A set of recommendations on the appropriateness of co-competition forms' choice is presented.

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