

# The influence of the integration level of the production and logistics cluster participants on its efficiency upon implementing import substitution program

## La influencia del nivel de integración de los participantes del clúster de producción y logística en su eficiencia en la implementación del programa de sustitución de importaciones

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#### ABSTRACT:

The analysis of foreign and domestic experience in the implementation of cluster models allowed for determining the principles of integration of their participants. The principles of consistency and parity shall be the basis for the formation of production and logistics clusters (PLC) of the Russian Federation, their successful innovative development based on public-private partnership. Solving the problems of a weak institutional structure will allow the PLC for implementing an import substitution program. The article makes a conclusion about the influence of the level of cooperation of the industrial cluster members on the result of its activity on the example of the timber industry complex of the Omsk Region. Therefore, in the context of solving the tasks of import substitution, production and logistics clusters formed both at the federal level and at the level of the

#### RESUMEN:

El análisis de la experiencia extranjera y nacional en la implementación de modelos de clústeres permitió determinar los principios de integración de sus participantes. Los principios de coherencia y paridad serán la base para la formación de clusters de producción y logística (PLC) de la Federación de Rusia, su exitoso desarrollo innovador basado en la asociación público-privada. Resolver los problemas de una estructura institucional débil permitirá al PLC implementar un programa de sustitución de importaciones. El artículo hace una conclusión sobre la influencia del nivel de cooperación de los miembros del clúster industrial sobre el resultado de su actividad en el ejemplo del complejo de la industria maderera de la Región de Omsk. Por lo tanto, en el contexto de resolver las tareas de sustitución de importaciones, los grupos de producción y logística

constituent entities of the Russian Federation become an actual form that is adaptive to the current situation in the Russian economy.

**Keywords:** import substitution program, adaptive forms of integration, business entities, industrial clusters, production and logistics cluster

formados tanto a nivel federal como a nivel de las entidades constituyentes de la Federación de Rusia se convierten en una forma real que se adapta a la situación actual de la economía rusa.

**Palabras clave:** programa de sustitución de importaciones, formas adaptativas de integración, entidades comerciales, clusters industriales, cluster de producción y logística.

## 1. Introduction

Industrial clusters are essential for territorial development of industry. This is especially relevant in considering the existing Russian and international experience in providing organizational and financial support from national and regional governments and administrations as per the Decree of the Government of the Russian Federation as of July 31, 2015 No. 779 (as amended as of Aug 02, 2018) "On industrial clusters and specialized organizations of industrial clusters" (Government of the RF, 2015).

The critical problem of cluster structures in Russia is the discrepancy between the actual level of development of productive forces in the old industrial subjects of the Russian Federation and the requirements for regional innovation clusters within the framework of the dominant concept of integrating business structures (Vasiljeva, 2013). One of the obstacles to the formation of clusters aimed at import substitution is the weakness of the institutional structure both at the federal level and at the level of the subjects of the Russian Federation.

The principles of consistency formed in the territorial-industrial complexes of the Soviet period and the implementation of the principle of parity in a market economy should be the basis of modern production and logistics clusters in Russia, which is especially crucial for Siberia and the Far East.

Scientific studies on cluster models reveal the consideration of them as a kind of integration of business of different levels on appropriate principles:

- Modernization of technologies and production processes based on innovation;
  - Cooperation with educational institutions and institutes of science, as well as the growth of professionalism of employees of organizations;
  - Forming a single space that takes into account the financial, innovation, technological, legal, and informational aspects;
  - Creating a unified strategy and commercial policy in the field of foreign economic activity.
- Cluster mechanisms, as shown by many studies, also allow the creation/operation of clusters to invest in various projects simultaneously (Voinarenko, 2007; Bezrukova, Morkovina, Jiang, 2013; Yanchuk, 2013; Žižka et al., 2018; Brinza et al., 2015).

Clusters are one of the components of the territorial-industrial complexes and industries, the operation of which is carried out within the boundaries of the subject of the Russian Federation, but the expansion of these boundaries is possible if there are advantages (Vnukova, 2010; Pshenichnyi, Gerasimov, 2010).

The typology of clusters defines sectoral and inter-sectoral clusters centered on a specific field of activity, for example, the construction industry cluster, which includes a certain share of the chemical industry and produces various chemicals.

Transport and logistics cluster structure can be attributed to a complicated sectoral nature, so the cluster subjects are assigned to the transport industry: railway, sea and river ports, terminal owners, airports, carriers, forwarders, etc. The cluster also includes a financial structure, a significant consignee, the largest consignor, a customs broker, a service company, an information company, and an insurance company, which makes the cluster to be an inter-industry one. In practice, organizations (enterprises), regional research and industrial centers; the presence of minerals and natural resources are not decisive and do not provide the likelihood of creating a PLC in the subjects of the Russian Federation.

The study of cluster models proves that the integration of organizations and companies into useful structures of a new form results in that if all the requirements for clusters are met,

including legislation (partnership and cooperation, coordination, communication, production specialization, successful concentration, application innovation), it is possible to achieve the task of import substitution (Prokofieva and Ellaryan, 2014).

Mutual trust and responsibility should be the basis for strong partnerships between individual "centers of competence," taking into account the interests of all parties. The leading countries of the world, which use clustering, and these are 50% of the economies, ensured the growth of GDP in the range of up to 70%. The USA states have created distinct cluster strategies in several hundreds of territories and cities, for example, Silicon Valley, employing about 2.5 million people. Germany has the world's best high-tech clusters: Hamburg, Dresden, and Munich - the "Silicon Valley of the XXI century" (Voronin, 2008).

A cluster differs from a cartel and a financial group in that competitive relations between the largest organizations remain. To implement the policy of import substitution in Russia, companies with cooperation in clusters will become carriers of a single "commercial" ideology.

Specific technologies work on equipment, materials, etc. a certain quality and quantity that are used by the largest enterprises and companies that are leaders in the world market, which forms the corresponding segment for small and medium-sized businesses seeking and developing competitive advantages on an innovative basis. The cluster structure provides for jobs and the volume of orders for suppliers of conventional components and entrepreneurs, who characterize the international competitiveness of the state.

Closer intra-company links in a cluster form a more profitable production structure than in the industry. The production factor involved in the creation of several types of goods at the same time creates the effect of coverage and reproduces the advantage for the cluster. The overall standardization of goods and services is carried out by a synergistic effect in the production structure of the cluster. Synergy, being a combination of the effects of coverage, gives additional advantages in the competition to the cluster members.

The state and municipal authorities of the constituent entities of the Russian Federation need to apply radically new competencies, including targeted programs and a policy of flexible priorities, for the implementation of the cluster approach.

The cluster approach will provide the following benefits at the level of the subject of the Russian Federation:

- Cluster organizations get additional benefits due to internal specialization and standardization, minimization of their costs for innovations occurs;
- Providing small businesses with the ability to service a specific niche to increase the level of specialization;
- Constructing a sustainable system of distribution of technology, products, and new knowledge, the formation of a technological network based on a joint scientific base;
- Creating innovative points of regional economic growth.

The purpose of the research is to determine the dependence of the industrial cluster efficiency on the integration level of its participants in the conditions of import substitution.

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## 2. Literature review

Certain aspects of the formation of clusters, complex infrastructures, and network organizations in the context of global industrial development are addressed in the works by Porter M.E. (1998), Malhotra Nares K. (2003), Quinn J.B. (1991), Reich R. (1991), Monque P., Fulk J. (1998), Haywood J.B. (2002). Cluster models and identification of cluster boundaries for state regulation of the economy at the regional level are studied by Voinarenko M.P. (2007), Prokofieva T.A., Khairov B.G. (2016), Myrolyubova T.V. (2008), Borisova V.V. (2016).

A wealth of material is devoted to the issues of integration of business entities by Bowersox D. (2008), Mikheev A.N. (2005); the formation of the mechanism of state support for small and medium-sized businesses is disclosed by Aleshchenko and Karpov (2015), Novikov and Khairov (2015); aspects of innovation development based on integration and supply chain formation (SC) are disclosed by Shumaev and Brykin (2013), Sergeev (2010), and

Dybskaya (2008). However, to date, researchers have poorly developed tools that help substantiate the choice of an adaptive form of integration of business entities for the implementation of an import substitution program.

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### **3. Methodology**

The theoretical and methodological basis of the study comprises theoretical concepts, presented in the works of foreign and domestic authors, experts in the field of cluster model formation for solving various problems of the economy, including the implementation of the import substitution program.

The method of optimization is the methodological basis of the research (the linear programming problem is solved). The study used the methods of collecting primary and secondary information, statistical data analysis, and expert method.

The hypothesis of the study lies in the fact that the inefficient work of the industrial cluster is explained by the low level of cooperation ties between consumers and suppliers. Using IBM ILOG CPLEX Optimization Studio 24 software, calculations and informatization of the presented mathematical problem were performed. The transportation task is relevant for solving the problem of reducing logistics costs and can be considered as the initial stage of integration of small and medium-sized businesses for the implementation of import substitution programs for processing various types of raw materials in an adaptive form of a cluster.

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### **4. Results**

An adaptive form of integration of business entities for the import substitution program is the production and logistics cluster.

Analysis of the effectiveness of logistic flows in the PLC for processing raw materials on the example of the forestry complex of a constituent entity of the Russian Federation showed the adaptability of this form for the integration of business entities based on PPP with elements of MLP.

The study revealed that the integration of the transport, logistics, and forestry cluster affects the structure of the production and logistics cluster of Russia. It is substantiated that the formation of a PLC requires significant investments on the basis of PPP with MLP elements in technical, technological, organizational and managerial innovations of the development of transport and logistics infrastructure, ensuring the logistical integration of participants in the SC and business partners in forestry enterprises, taking into account regional characteristics and socio-economic interests in the PLC.

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### **5. Discussion**

#### **5.1. Analysis of the effectiveness of logistic flows in the PLC for raw materials processing**

Currently, the domestic economy needs competitive innovation-oriented territorial and sectoral structures - production and logistics clusters. These structures include an interdisciplinary cluster, in which several organizations concentrate structurally heterogeneous, but systemically related industries that complement each other and increase their competitiveness.

The adaptive form of integration of small and medium-sized businesses for the import substitution program is, therefore, the production and logistics cluster. A PLC adequately and quickly responds to the impact of the environment by innovation, is built by a logistic approach and the restructuring of organizations in a particular industry.

The creation of a PLC and the development of a logistics network in forestry enterprises of a constituent entity of the Russian Federation is associated with the development of algorithms and a set of technologies based on logistics activities.

Classification of logistic processes and their identification allow controlling the formation and movement of various flows.

A single logistic system in the PPP format in the interaction of business and the state creates logistical flows (material, financial, informational).

The need to create a PLC is considered on the example of the wood industry complex of the Omsk region. The inaccessibility of the forest area, not functioning transport network, being distinctive characteristics of forestry enterprises of the subjects of the Russian Federation, determine the factor of the seasonality of work. There are areas in the region where logging work is feasible only in the winter period.

Forestry enterprises of a constituent entity of the Russian Federation can be represented from the standpoint of logistics as a multi-level macro-logistical system, where the logistic flow is formed from the transport and technological processes of forest resource movement from the place of harvesting to consumers, but already with a change in consumer qualities.

Associations of independent forest industry organizations that own and use their logistic networks are the basis for the formation of SC. Taking into account specific commercial interests, it is required to create a system of supply chain management of the highest level, which will be considered as a subsystem for a higher level - a consolidated group or holding.

Within the framework of the regulatory field, obligations are not always fulfilled in terms of conditions to maximize business profits, and the government limits entrepreneurs with rules and regulations, creating additional conditions on a par with existing ones: social, technological, economic in forestry enterprises. The composition of logistic flows and SC management is heterogeneous in forestry enterprises and has many limitations (time, volume, etc.) due to the potential of organizational and economic structures and the development of territories.

In space, the structure of the material flow often changes due to changes in the location of production resources. The development of territories requires transport development to develop a network of forest roads.

In the Russian Federation, the use of resource outsourcing is considered to be a prerequisite for the functioning of the forestry complex, since the forest as a resource must be leased, while building, structure, equipment, and machinery are also rented (Porter, 1998). Operational outsourcing in forestry enterprises is represented by attracted contractors engaged in logging, forestry, and road construction works, transportation.

The logistic approach to the management of SC in forestry enterprises is applicable to make complex decisions at the strategic, tactical and operational levels to perform practical tasks, which should take into account algorithms and interrelated models of operations research, the integrated paradigm and the probability-adaptive approach.

Features of the concept of supply chain management in the Russian forestry enterprises complex to integrate small and medium-sized businesses for the import substitution program:

- Expansion of the range of products according to market demand and the possibility of choice;
- Prohibition of actions to arbitrarily change the distribution of raw materials for forest resources regardless of their quality characteristics, the rejection of one commodity in favor of another;
- Spatial organization of production, taking into account the movement of material flows and the formation of the industry supply chain with various combinations of technology, types of machines, equipment; options for multimodal transportation;
- Application in production practice by logging enterprises of operational and resource outsourcing.

Logistic integration in adaptive forms like PLC will require the integration of small and medium-sized businesses to manage commodity and information flows in the international and domestic markets while observing the established rules and international agreements

for import substitution.

We will analyze the effectiveness of logistic flows in an adaptive form of integration of small and medium-sized businesses as a PLC for the processing of raw materials on the example of the forest industry complex of a constituent entity of the Russian Federation. To do this, consider the potential of the forestry enterprises of the Omsk region, the problems of which are similar to other subjects of the Russian Federation.

Let us analyze the material flow as the main flow, while the information and financial flows in the situation in question are concomitant to assess the effectiveness of the existing logistical flows in the forestry enterprises SC.

Following the specifics of the forestry enterprises, the speed of the flow from the logging to the woodworking determines the speed of the vehicle that performs the transportation. This indicator is adjusted depending on the following elements: the speed of the material flow in the forestry enterprises is influenced by seasonality, as it depends on the presence or absence of a winter road for the transport of wood products; as a rule, within the logistics chain, the distance between the woodworking and logging sections is constant; the changeable trajectory of the material flow in the forestry enterprises, which is dependent on the climatic conditions, and the adjustment of the route may not be feasible due to additional costs that are aimed at increasing the trajectory (Barney, 2009).

The export of wood in a certain period determined the need to solve the transportation problem to optimize cargo transportation from loggers to woodworkers. As a result, the trajectory, starting and ending points of the movement, the speed of transportation were determined.

It is recommended to consider the seasonality factor in optimizing the transportation of products of the forestry enterprises (optimization of wood delivery from logging to woodworking), which is presented for the regional level using the example of the forestry enterprises of the Omsk Region, which has problems in the Russian forestry enterprises complex (Khairov, 2006).

To calculate the optimal transportation of goods from the point of departure to the destination with the minimum cost of transportation the authors use the mathematical problem of linear programming (transport problem).

Assume  $a_1, \dots, a_m$  are suppliers (logger),

$b_1, \dots, b_n$  are consumers (woodworkers),

$c_{ij}, i = 1, \dots, m, j = 1, \dots, n$ , is the cost of transporting a unit of cargo from supplier  $i$  to consumer  $j$ .

Let us will draw up a transportation plan, in which the stocks of all suppliers are exported in full, the demands of all consumers are fulfilled completely, and the total costs of transportation are minimal. Let the variables  $x_{ij}, i=1, \dots, m, j=1, \dots, n$ , be the traffic volumes from supplier  $i$  to consumer  $j$ . The mathematical model of the problem has the form (12):

$$\sum_{i=1}^m \sum_{j=1}^n c_{ij} x_{ij} \rightarrow \min \quad (12)$$

with the limitations:  $\sum_{i=1}^n x_{ij} = a_i, i = 1, \dots, m, \sum_{i=1}^m x_{ij} = b_j, j = 1, \dots, n,$

$$x_{ij} \geq 0, i = 1, \dots, m, j = 1, \dots, n.$$

In this model, it is assumed that the suppliers' stocks are equal to the demands of consumers (13):

$$\sum_{i=1}^m a_i = \sum_{j=1}^n b_j, \quad (13)$$

i.e., the task is open.

The task is considered on the example of logging and woodworking enterprises.

The distances between the regions will be defined as weights (transportation cost), where similar organizations are located.

Using IBM ILOG CPLEX Optimization Studio 24 software, calculations and informatization of

the presented mathematical model were made from data (the volume of wood logging in the Omsk Region).

The profitability of the flow in the interests of entrepreneurial structures of the cluster of the forestry complex of the Omsk region in the context of a single macro-level SC has been revealed. The flow efficiency was calculated taking into account the interests of entrepreneurial structures of the cluster of the forestry enterprises; available reserves were identified during the integration of the micro supply chain into a single macro supply chain.

The inefficient work of the forestry enterprises is explained by the low level of cooperation ties between consumers and suppliers. The provided transportation task is relevant for solving the problem of reducing logistics costs and can be considered as the initial stage of integration of small and medium-sized businesses for the implementation of import substitution programs for processing various types of raw materials in an adaptive form of a PLC.

The economic effect of the partnership of participants in the cluster of the Omsk Region forestry complex by optimizing the integrated supply chain when solving the transportation problem is 1,850,006.5 thousand rubles.

## **5.2. Analysis of integration experience based on a combination of integration cooperation and partnership parameters**

Analysis of foreign, domestic experience has shown that integration is becoming a leading factor in improving the efficiency of the forestry enterprises and an objective prerequisite for the development of transport and logistics infrastructure, reduction of total costs in SC, attracts investments in organizational, managerial and technical and technological innovations.

The study assessed the effectiveness of the resource flow of the integrated supply chain of the cluster of the forestry enterprises complex of the Omsk region based on optimizing the delivery of wood from logging to woodworking, taking into account the seasonality factor, and the transport task is presented as an initial stage in creating a PLC to enhance cooperation between consumers and suppliers.

The world economy is represented by the processes of globalization and internationalization. Therefore the cluster approach is decisive in choosing a strategy for the country's socio-economic development (Asaul, 2008; Handfield, 2003).

In the world, Russia ranks first in terms of forest area reserves and second in wood reserves, while the share of forest products production is significantly reduced due to the inefficient use of raw materials.

Russia has competitive advantages: natural potential and geographical location at the intersection of EU countries, South-East Asia and the Asia-Pacific region, which should be taken into account and developed by an innovative approach.

The cluster management model is applied in the forestry policy of economically developed countries (Canada, USA, Finland, Sweden, Austria), which have forests. Deep processing of wood and high-tech equipment is used in wood production in foreign wood processing complexes.

Russian export of forest resources is directed to the countries of Scandinavia, Western Europe, and Southeast Asia.

Domestic forestry enterprises are distinguished by low added value and low levels of wood processing. Russian forestry enterprises have added value below 2%, and in Finland, it exceeds 20%, in Russia, 20% of forest wood is undergoing deep processing, while in Finland it is 85%.

The Finnish forestry cluster is characterized by a balanced and high level of development and coordination of the primary and auxiliary production; the presence of great competition in the association; advanced innovative, world-class development; an active intra-cluster partnership in the creation and implementation of joint projects, as well as joint work with

inter-sectoral organizations. At 0.5%, of the world reserve of the forest fund produces about 10% of the world exports of wood processing products, of which 25% of the world exports are quality paper. The Canadian forestry industry cluster is also known.

Domestic experience in the development of forestry enterprises is negative since 99% of business entities are uncompetitive. Formation of competitiveness in solving social problems contributes to the support of business entities in the forestry enterprises at the stage of the implementation of logistics solutions in their activities.

The structure of government, as shown by foreign experience, is directly involved in the development of cluster formations; these include the centers of cluster development agencies. Such experience is relevant for the constituent entities of the Russian Federation since today, not separate companies are competitive, but their associations (clusters, networks, groups) for them to form technological centers seems to be an objective necessity.

The prototypes of regional production clusters in Russia are territorial production complexes (TPC). A modification of this model is necessary to bring it in line with the market economy and the process of globalization. The need for the development of logistics is dictated by the need for innovative sustainable development of the domestic economy through the introduction of an innovative approach. At the same time, there are fundamental features of the state's approaches to the processes of expansion of both international and domestic trade, and the unification of Russia into the world global market.

The sectoral specificity of the country within the framework of the cluster policy concept defines 5 types of clusters, including transport and logistics cluster (TLC), which consists of a complex of infrastructure and companies that specialize in storage, escort, and delivery of passengers and goods. These include port infrastructure facilities; service companies; logistics complexes of the subjects of the Russian Federation with transit potential. These include port infrastructure facilities; service companies; logistics complexes of the subjects of the Russian Federation with transit potential.

TLC is an innovation-oriented model of integration in the market of transport and logistics services of its participants, based on the harmonization of the interests of counterparties of the supply chain and innovation, aimed at achieving a synergistic effect.

The intensive development of the logistics services market in Russia creates objective organizational and economic prerequisites for the formation of the transport infrastructure of the constituent entities of the Russian Federation and clusters. Regional transport and logistics clusters (hereinafter RTALC) optimize logistics processes to ensure the development of industry-specific priority, including industrial clusters of subjects of the Russian Federation, since in a globalized economy, the integrated logistics indicator - LPI (Logistics Performance Index) of Russia is 90 out of 160 countries according to the World Bank rating, which can lead to serious negative consequences.

Due to the low level of transport logistics infrastructure, the forestry enterprises have indirect, direct losses in the form of lost profits, as well as due to the low level of wood processing, the lack of deep chemical processing of wood, and the slow introduction of innovative technologies.

These problems can be solved by a PPP mechanism with elements of a multilateral partnership (hereinafter referred to as MLP).

The logistics restructuring of the forestry enterprises is associated with the formation of an average (meso) economic level - a PLC to search for options for optimizing the activities of logistics integration participants, at the level of specific subjects of Russia to solve the tasks of the import substitution program. This does not differ from the trends in the structuring of the modern economy in the world in the form of corporations with a network structure. Integration is considered hereto in the form of open logistic system/network architecture, specifying their functions in new relationships and creating conditions for attracting other partners.

The implemented economic and financial state mechanisms for supporting small and medium-sized businesses reflect in part the unpreparedness of Russian entrepreneurship to



civilized multilateral partnerships with other economic subjects.

Adequate, practical consideration of the priorities of the cluster development strategy in the context of the implementation of municipal and regional socio-economic development programs will accelerate the adoption of measures to support entrepreneurship involved in housing development projects, engineering and transport infrastructure; educational, technological and innovation policies; policies to attract investment, the development of industries, export development.

An innovative approach to the formation of forestry enterprises from logistic networks, PPP and MLP, will retain the interconnectedness of the chain of technologically dependent organizations/enterprises performing various functions in the regional production process.

The search for the optimal combination of the parameters of integration cooperation of participants of PPP and MLP is relevant for all planes of process research: economic, environmental, legal, social, and technical. The presence of problems impeding the creation of integration associations determines the specifics of the conceptual solution:

- Minor financial opportunities and innovative activity of the majority of participants of the forestry enterprises;
- The insufficient production capacity of individual industrial enterprises and associated resource constraints.

The mechanisms of municipal-private and public-private partnerships will prevent the adverse effect of these factors when introducing the optimal form - regional production clusters for the coordinated consolidation of participants in the forestry enterprises.

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## 6. Conclusion

Integration of small and medium-sized businesses is aimed at addressing the program of import substitution and competitiveness, the efficiency of the forestry enterprises of both individual subjects and the country. It is substantiated that the known mechanisms - industrial clusters for the processing of various types of raw materials, including woodworking, will form the basis for the formation of regional forest processing PLCs. Investments are required to launch the project from the introduction of PPP mechanisms with elements of MLP both in technical and technological innovations and organizational and managerial for the development of transport and logistics infrastructure. Taking into account the regional characteristics and socio-economic interests of the participants of the integrated supply chains - business partners in the forestry enterprises will ensure the rise of the industry and solve the tasks of the import substitution program.

The basic idea is that using world experience in improving transport and logistics clusters/logistics infrastructure as a whole, successful innovative Russian development requires own development of management technologies based on the latest scientific achievements.

The production and logistics cluster formed on the basis of the restructuring of organizations (companies) of a particular industry, innovation and logistics approach is able to respond quickly to all changes in the external environment, which defines it as an adaptive form of the process of integrating small and medium-sized businesses in order to implement the import substitution program.

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