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INNOVATION CLUSTERS DEVELOPMENT: CASE OF ARCTIC PROJECTS IN SHIPBUILDING INDUSTRY

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Abstract

The authors of the article make an attempt to research the development of innovation clusters in shipbuilding industry. This subject of the research is very relevant for the Russian Federation in conditions of increased interest in the exploration of the Arctic. Based on the analysis of the current condition of the shipbuilding clusters development, the authors come to conclusion that for realization of the most large-scale projects, taking part in governmental programs, including an intersectoral cluster, more innovative technologies are necessary than those created inside it. So this puts emphasis on the technical mental component of the core, but it happens at the higher level because entering a new field of knowledge and new competence takes place. The core of any cluster is educational institutions and engineering companies. The authors created the model of the dynamic mental core of innovation clusters. Any cluster functioning includes a number of factors: technology, skills, competences, and knowledge.

Keywords: Innovation, cluster, knowledge, Arctic, shipbuilding industry.

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1. Introduction

The modern author's view on the development of clusters is based on the priority of research and engineering activity. Research and educational organizations, construction departments, engineering companies are considered to be the most important subjects of the innovation clusters that create their intellectual core. The core determines innovation results of key participants of intelligent interaction that gives high innovation concentration and stimulates increasing of enterprise and industry competitiveness.

The authors of this article created the model of the dynamic mental core of innovation cluster Sapience Integra (Trifonova, Klementovichus, Melnikova, Proshkina, Vardanyan, 2017). This model modifies well known conception Triple Helix (Etzkowitz & Leydesdorff, 1995) for a concrete definition of nature and detection of the mobility factors of the innovation cluster component.

The dynamic mental core of the innovation cluster (figure 1) is based on the assumption that a system-forming element of the innovation cluster is resistant to the time total intellectual result of innovation cluster functioning. Technology, skills and competences can be identified in this result. Technology is an algorithmic result of collective intellectual activity as a rule. Skills and competences are reproduced in action results of intellectual activity. Knowledge is described as a result of intellectual activity that can be translated.

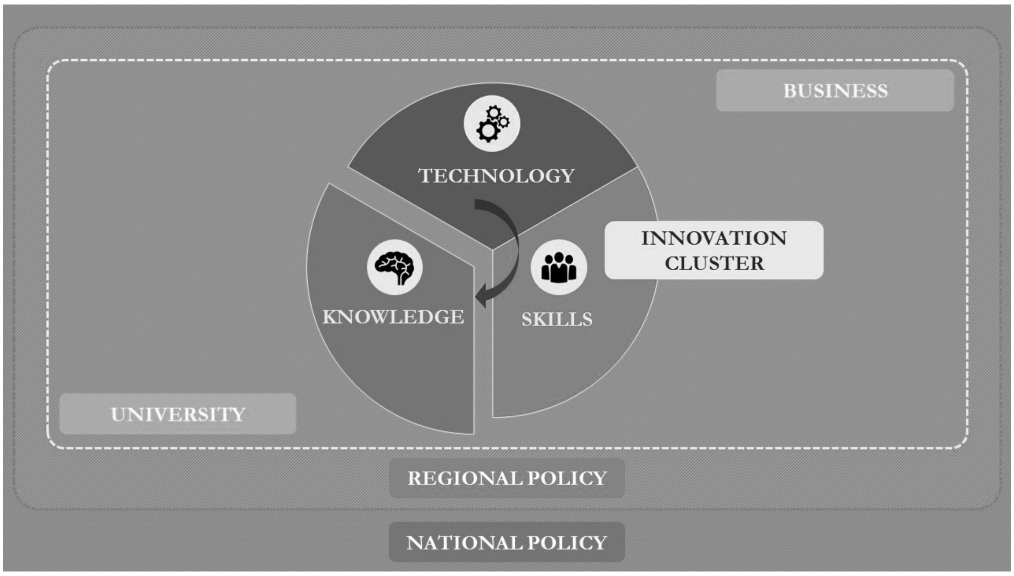

Figure 01. The model of dynamic mental core of innovation cluster Sapience Integra

The core has dynamic nature. It allows analyzing the evolution of its structure from technology domination through the skills predominance phase to prevalence of knowledge creation. The innovation cluster in the core structure can be classified as technological when technology result dominates (1) that is proved by the largest representation in its structure and business-structure and elements functional. The evolution of the cluster causes key personnel skills and elements of organization competence's domination in its intellectual results that occur within transitional phase (2) of innovation cluster development. Then this phase takes turn by the transformation period of domination actual for industry, location and global community knowledge (3), translated by enterprising university as the head structural element. This type of the innovation cluster can be determined as research and entrepreneurial.

The introduced logic model captures the process of cluster functioning in progress, but does not describe its dynamics that takes place in the core because of the further possible changes in cluster operation, structural and spacial-territorial changes, in particular

2. Problem Statement

The question of direction determination and searching for drivers for further development arises. There are functioning clusters not only in the process of negative market changing, but also when there is the possibility to participate in a big project, to develop new markets. In this situation it can be not enough to have internal resources and internal innovation potency of the cluster to provide and withhold technology leadership, to create radical innovations, especially when temporary restrictions take place.

In present time it is proved that in order to create the radical innovations companies need to communicate outside the cluster. Due to the conception "local buzz - global pipelines" (Bathelt, Malmberg, & Maskell, 2004; Feldman & Kogler, 2010), both regional and "extra-regional" relations are important for the innovation capability of firms, but for different types of innovations.

Locating within an industrial cluster gives certain advantages, in particular by means of integration to "industrial atmosphere", "noise" (Grabher, 2002), "buzz" (Storper & Venables, 2002). Buzz consists of the specific information that is created, transferred and separated within the same industry and place (or the region). Engagement in the process of knowledge creation and transferring, learning the technology, exploring working schemes is caused by the factor 'being there' itself, temporary communication and working cooperation of the specialists, monitoring the other company activity. But for getting new and/or specialized knowledge and competence, companies create information channels for selected actors outside of the region, named global pipelines. Local buzz provides diffusion of existing knowledge that can stimulate incremental innovations, but for the creation of new knowledge and the development of radical innovations, global pipelines should be used.

Such communications can be realized by all actors belonging to a cluster, especially the one that plays the most important role – key producers and suppliers of specialized resources, services, technology, equipment, research and educational organizations. It is worth noting that we can talk simply not about making partnership, but also about dimensional increasing of cluster limits. Territorial integrity and cluster limits are a question that continues to be discussed by the researchers. So Porter (Porter, 2000: 254) defines a cluster as "a geographically proximate group of inter-connected companies and associated institutions in a particular field, linked by commonalities and complementarities". Herewith he claimed that the geographic scope of a cluster can "range from a single city or state to a country or even a group of neighbouring countries."

There is the question on how going beyond the locations and occurrence of new communications and/or participants influences the dynamics of the mental core, in case of analysing this process through the model Sapience Integra.

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3. Research Questions

The opportunity of the mental core development by means of its increasing out of the territorial location borders becomes the key aspect of the research. In the course of the analysis, the following questions were covered:

- What processes cause territorial development of the cluster?
- Which organizations can be the partners for appearing or existing clusters in order to develop technology?
- Which clusters will be formed the first in the context of Arctic regions in Russian development?

4. Purpose of the Study

The purpose of this research is the analysis of existing clusters on the subject of making technology partnership with external actors and influence of formed communications on development of innovation clusters mental core. Considering actual tasks, facing Russian economy, to develop Arctic region, shipbuilding clusters are determined to be the subject of the research.

In the present time, environmentally sensitive Arctic turns from a “frozen desert” to the object of different economic and political interests of a rather representative list of countries, economic agents, and public organizations. Russia is in the top five countries that have access to the resources in Arctic, as well as the USA, Canada, Norway and Denmark, is the member of the international regional organization – Arctic Council – together with Finland that is an initiator of it, Sweden, Norway, Iceland, Denmark and USA. In the result of biophysical, technological, economic and ecological changes, other countries are becoming more interested in Arctic: among interested agents, there are non-arctic countries of EU, China, for which working in Arctic is economically profitable and geopolitically preferable: mining companies, shipping and fishing companies, tourist sector, banks and insurance companies. At the same time, Arctic is the priority area of Russian energy and national security, which development is possible only in case when strategic partnership between internal operators of large-scale regional projects and dialogue with international industry leaders take place.

The key question in the development of Arctic is the improvement of the transport network, because without solving this task opportunities of the region are greatly reduced. In this regard, North Sea Route (NSR) is the unique competitive advantage of Arctic logistics. North Sea Route unites sea routes, internal waterways in Siberia, air and pipe lines in the single transport network. The advantage of NSR is its length: length of the route from Yokohama (Japan) to Rotterdam (Holland) using NSR is almost 33% shorter, and length of the route from Rotterdam to Vancouver (Canada) is shorter by almost 22%. The passage of a cargo ship along the North Sea route to the different ports of South-East Asia reduces travel time from 7 to 22 days compared to the passage through Suez. Despite the obvious saving of fuel resources and optimization of freight expenses, difficult navigation in ice and increased demands to the ship class are a disadvantage. In the nearest years, the increase in the shipping intensity is expected in the water area of NSR as well as the increase of the large-capacity ships share that have high categories of ice strengthen, extension of navigation terms and construction of new generation icebreakers.

The navigation period at the Eastern Arctic sector that is no longer than seven months made it necessary for an engineer to build new generation icebreakers. Icebreaking capability of new generation

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icebreakers should be 2.6–2.9 m. Then icebreaking capability of icebreakers that are in operation is no higher than 2.3 m. It is necessary to increase the main power plant capacity 2-3 times (to 100-130 MW) in order to reach needed speed of industrial wiring and an appropriate level of icebreaking capability. At the present time, with the support of “Rosatom”, project 22220 is being implemented that suggests building a nuclear icebreakers type LK-60YA which capacity is 60 MW. The project includes icebreakers “Arctic”, “Siberia”, “Ural” that are expected to be put into operation in 2019-2022. In 2013, on the building berth of Baltic plant, the first (head) two-stage new generation nuclear icebreaker “Arctic” was laid on the project of CDB “Iceberg”. The possible building of the nuclear icebreaker “Leader” with capacity 120 MW is also under consideration. With the help of this icebreaker, the effective year-round navigation will be provided by raising winter speed of ship’s wiring that is especially important when container shipment is carried out on schedule.

The other important problem of using NSR is flotation of large-capacity ships. To provide appropriate ice channels, new icebreakers are also necessary and Russian organizations are working on it. Krylov State Research Centre developed the project of building 3-body turbo-electric icebreaker capacity of 60 MW shafts (project ML-60). This icebreaker is a fundamentally new architectural type, which can create an ice channel with a width of more than 50 m, and the work of the icebreaker is carried out with the consumption of a relatively small level of power. Besides nuclear icebreakers, Russian shipbuilding companies are developing and building gas carriers for the transportation of liquefied natural gas, large-tonnage tankers for ice navigation, container ships, marine rescue tugs of Arc 5 class and small marine tankers of Arc 4 class.

The demand for icebreakers and ice-class vessels, as well as extreme conditions in high latitudes on the Arctic shelf, required the creation of cold-resistant steels with high strength and ductility characteristics. The technologies developed so far for the production of sheet metal from high-strength case steels are based on the principles of achieving the required properties mainly due to alloying with expensive elements, such as nickel, which largely determines the high cost of production. At the same time, modern metallurgical and rolling technologies make it possible to achieve the necessary properties of steel through the use of innovative approaches. In particular, the following methods are used to improve performance characteristics such as steel refining, grain grinding, deoxidation and modification of alkaline earth and rare earth metals. In the framework of public-private partnership, the project "Metal" was implemented - an innovative project of national importance "the Creation of technology and the development of the production of metal materials with a twofold increase in properties." CRISM "Prometey" named after academician I. V. Gorynin acted as a leading scientific organization that took part in the development of a number of cold-resistant materials suitable for use in the Arctic region.

The production of cold-resistant steels for Arctic projects is becoming an important element in the development of shipbuilding clusters. The search and development of innovative technologies are an urgent task for the existing shipbuilding clusters. There are questions about the possible expansion of the cluster members and the formation of new integration links on a regional and national scale.

Today we can talk about the formation of a shipbuilding cluster, which is characterized by undoubted technological leadership, an independent position in the sanctions regime and the prospects for the demand for food and technological results in the framework of both domestic and foreign Arctic projects.

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5. Research Methods

The theoretical basis of the chosen research approach of the authors is a logical structural model describing the cluster as the interaction of territorial-state institutions, business and University community. A case study was chosen as the main method. Using this method is advisable if you need to answer the questions "what happened?" and "how / why did anything happen?", and the observed variables are context dependent, and it is not possible to define them in advance. Analysis of the business situation can be defined as an in-depth sample study of a problem on one single, but representative object. The observed phenomenon is described in as much detail as possible, several typical business situations are investigated in order to formulate hypotheses and/or draw as general conclusions.

The shipbuilding industry was defined as an industry restriction. Russian shipbuilding clusters are active participants in the implementation of large-scale projects for the development of the Arctic.

For analytical purposes, data on cluster development and examples of interaction between cluster members and external partners are presented and described.

6. Findings

The study of foreign shipbuilding clusters has shown that their successful functioning and innovative development require external relations.

South Korea

Thus, the shipbuilding industry, which plays a significant role in the economy of South Korea, is concentrated in the South-East of the country. The facilities of the shipyards are mainly located in the districts of Ulsan, Busan and Geoje. However, in recent years, the reorientation of companies within the cluster has led to the development of extra-cluster linkages dispersion and internationalization of the cluster itself (Shin & Hassink, 2011; Boschma & Fornahl, 2011). Extra-local linkages at the national level provide a cluster with labor and materials: steel plates are supplied from Pohang, where the largest company POSCO – the second largest steel producer in the world – is located, engines and other mechanical engineering Technology from Changwon, which is specialized in machinery; and highly qualified staff is hired in Seoul and Daejeon. International relations – with countries where shipbuilding is developed – provide access to technologies, a special need for which arose at the end of the 20th century.

After the Asian economic crisis in 1997, the largest Korean shipbuilders made active attempts to switch to a new market segment - higher value-added ships, requiring advanced technology, and cruise ships, which required advanced technology. The companies opened its own research centres, bought the license and had been trained by foreign companies. The centres were opened both inside and outside the cluster: in Ulsan, it was founded by the research centre of Hyundai Mipo, and Samsung opened shipbuilding research centre in the city of Daejeon in the middle of the country. Some public research institutions located in the city of Daejeon (Daedeok Science Park) in Seoul, the universities in the cities of Busan, Daejeon, and Seoul producing engineers were involved as well.

International extra-local linkages provide Korea not only with markets, but also with the high-quality parts, materials and technology necessary for the production.

Norway

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Successful experience in the development of the shipbuilding cluster in Norway is largely based on the integration activities of Norwegian companies. For example, due to the increase in labour costs, it is becoming more common in shipbuilding that parts of the ship are built in the Baltic countries, and the final Assembly takes place in Norway. The cluster itself is often referred to as a global knowledge hub, which creates a global network of participants (OECD, 2017). The state, local universities and representatives of the business community closely cooperate and support each other in the process of developing and implementing innovations. It should be noted the specialization of regional clusters. For example, Trondheim houses research institutes and organizations, while Oslo houses companies specializing in financial and legal matters related to the development of the shipbuilding industry. The shipyard is located in the North-West of the country.

Finland

Finland's shipbuilding industry remains internationally competitive, largely due to its ability to innovate and develop new techniques that are widely used around the world. The shipbuilding cluster of Finland is a dynamic integrated structure based on cooperation of participants in different regions of the country. It includes competitors (horizontal relations), companies downstream or upstream in the value chain (vertical relations) of the maritime industry, as well as public sector actors (e.g. research, education and regulation). In order to support the development of the Finnish cluster, a number of projects aimed at expanding the network of participants were developed. For example, FinBraTech is a partnership of Finnish and Brazilian educational and research organizations in providing support for Brazilian and Finnish marine and technology industry companies in their businesses and international co-operation. FinBraTech is coordinated by Turku University of Applied Sciences. FinBraTech can provide support in the technological issues of the industry, offering RDI-services and training of staff and engineers.

Russian shipbuilding clusters

In Russia, there are prerequisites for the creation of shipbuilding clusters in several regions: North-West, Far East, South and Central. Somewhere, for example, in the Far East, the clustering process has been launched relatively recently. In other regions, shipbuilding companies have historical prerequisites and conditions for close cooperation. For example in Saint-Petersburg, about 40% country's shipbuilding capacity is concentrated, also more than 75% of all design and research organizations in the field of shipbuilding (according to TSSR "North-West"). The main advantages of the Northwest cluster include a combination of scientific, design and production components, as well as the presence of related and service industries. These conditions contributed to the concentration of companies and large branches of the majority of key customers, credit institutions and centres of innovation in shipbuilding. This combination makes it possible to design and build special-purpose sea-class vessels with the ability to operate at high latitudes: for the production of hydrocarbons on the shelf, commercial operation of the Northern Sea Route. The region actively cooperates with leading universities of the city, and universities are working to integrate into global scientific, educational and innovative networks and contribute to their formation.

The creation of a shipbuilding cluster in Arkhangelsk also implies an active focus on innovation and proximity in the development of Northern latitudes. In Astrakhan, this sector is a priority for the region's economy in connection with the development of oil and gas projects. Prerequisites for creating a cluster exist in Central Russia (Nizhny Novgorod).

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At the same time, the market trends and the desire of shipbuilders to be close to the world's largest suppliers of components (the share of imports of equipment and units for shipbuilding in Russia is quite high and reaches 80-90%) stimulates the development of clusters in other regions. Thus, the development of shipbuilding in the Far East in close proximity to the rapidly developing Asia-Pacific region implies an increase in the competitiveness of Russian shipbuilding on the world stage.

However, the share of Russian shipbuilding in the global market remains small and amounts to 0.5% of deadweight. 70% of the Russian shipbuilding falls on the military nomenclature (21% - for export); civilian products account for about 30% of the nomenclature (export-less than 2%). The most promising sectors of growth in global trends are those market segments that require large amounts of research and development work.

In order to be in demand in the domestic market and to increase the potential for entering the world market, the activities of Russian shipbuilding clusters need to be adjusted taking into account the analysis of the range of promising products.

For example, one of the most promising types of vessels in the civilian sector is now gas carriers for the transportation of liquefied natural gas, which already have a demand in the markets of the largest Asian States. At the same time, the construction of high-tech, unique and small-scale vessels and watercrafts for the development of hydrocarbon deposits on the continental shelf of the freezing seas of the Arctic and the Far East, as well as ships for the transportation of the Arctic region becomes the main niche of competitiveness of domestic shipbuilding in the world market. This production requires advanced technological solutions.

Thus, the availability of scientific research and developments, and close cooperation with scientific and technical organizations is the requirement for competitiveness on the world shipbuilding market. At the head of territorial and intersectoral alliances today, there are not only the leaders of production, but also a powerful scientific and educational component. Its potential in many ways becomes the factor that determines the product specialization of the cluster and becomes its core. But a creation of such scientific centres requires great financial and time costs. In this connection, the scientific and educational core can not only be located closely to the cluster, but also come out of the territorial limits, providing competitiveness of the production as the result of close intersectoral communication.

7. Conclusion

For the implementation of special projects, participation in government programs, including cross-sectoral technologies that are born within the cluster, is not enough. Even if it is at the third stage of evolution, due to the offered model – research and entrepreneurial one, universities are not able to go beyond sectoral specialization and to propose appropriate solutions. Then residents of the cluster establish links with other enterprises located outside the cluster: research centres, design bureaus, production companies. This again shifts the focus of the cluster to the technological component of the mental core, but at a higher level, as there is a new area of knowledge, the sphere of competences. The development is on an upward spiral and then repeats the already described stages in the evolutionary development of the mental core (fig.2).

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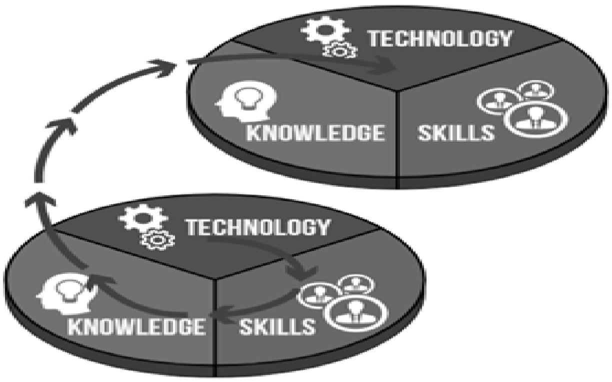

Figure 02. Spiral development of the mental core of the innovation cluster

The development of new technologies leads to the formation of new skills of key personnel and elements of organizational competencies, and at the next stage universities pick up and integrate new directions in the existing system of knowledge production.

Thus, the development of the mental core of the cluster is carried out in a spiral and can occur due to its expansion, going beyond the territorial location.

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