The Russian Arctic World-class research and education center formation

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Abstract—**The article addresses the formation of the human capital in the digital economy for the Russian Arctic. The urgency of the problem is stated; the requirements formed by the processes of digitalization in the economy are indicated. The negative trends regarding the development of the human capital in the Russian Arctic are shown. The expediency of the creation of a world-class Scientific and Educational Center in the Russian Arctic based on two regions - the Murmansk and Arkhangelsk regions is substantiated. An integration model of center formation is proposed based on the principles of a convergent network approach of interregional interaction in which participants within a single integrated system "science - education - production" are connected by integration relations to maximize usage of each scientific, industrial and human potential.**

Keywords — human capital, digital technologies, the Arctic, the world-class research and education center (REC), convergent network approach, Murmansk region, Arkhangelsk region

I. Introduction

The transition from industrial to network economy requires a structural transformation of the socio-economic management system. The human capital becomes the most important factor to make such a transformation. In the digital economy human capital acquires new informational content, functions and competencies [1].

Meanwhile, the problem of the lack of highly qualified specialists who are able to effectively interact with each other in the modified conditions of the digital economy is particularly acute. Therefore, the role of a state, market and network institutions in the preparation of highly qualified specialists with new network skills and competencies is of vital importance in this context.

Practice shows that in the digital economy the process of formation of network institutional management structures is underway, including government institutions as well as self-organized network communities. Modern digital technologies transform interpersonal relations in the society: new virtual networking communities emerge with the high speed, information partnerships are formed quickly and users are being segmented by goals. Thus, the principles are being transformed as well as the relations of interaction between the stakeholders. It raises the issue of the company management as well as the public administration issues.

II. LITERATURE REVIEW AND PROBLEM STATEMENT

In a digital economy the most important areas of the state regional policy implementation are:

- maintenance of innovative activity of the region and its investment attractiveness;

- the formation of the inter-regional relations at a new level;

- development and effective use of human capital in the region;

- elimination of regional disproportions in the socio-economic development of the region.

The latter issue becomes particularly relevant since the digital economy brings to the new level the problem of the "feet voting" by Charles Mills Tiebout providing additional opportunities for increasing the mobility of the population looking for work, including remote access jobs and distance education. Thus, the problem of the preservation and development of human capital in regions with unfavorable socio-economic conditions, especially of highly qualified specialists, is becoming more acute. It is not coincidence that the problems of the formation of human capital in the Russian Arctic are considered in many scholarly writings of Russian scientists, including [2] identified factors affecting the development of human capital in the Far North environment. In [3], the relevance of introducing digital technologies into human resource management in the Arctic is shown.

Note that the population of the Russian Arctic regions has been decreasing despite the whole range of measures aimed for the development of human capital. The rate of migration growth in the Murmansk region remains negative for the entire period starting from 2000, although it is declining in absolute value (from 16.5 in 2000 to 4.6 in 2017). According to the forecasts, the proportion of the working-age population will continue to decline. The average working age the Murmansk region is 40.8 years.

The unemployment rate is the highest among young people aged 20-24 and in 2018 was 18.4% to the total number of employed. Wages in education is one of the lowest according to the areas of work. By the year 2018 31.6% of the population had a higher education among working, upper secondary education - 15.6%. Among the unemployed - 21.6 and 23.6%, respectively. Expenditure on education in the spending patterns of the population decreases (from 1% in 2014 to 0.4 in 2018) while the expenditure on alcohol and tobacco products grows (3.5% and 4.1%, respectively) and by 2018 the sample survey shows that its share in the structure of household expenditures is 10 times higher than expenditure on

education. The number of organizations leading the training of graduate and doctoral students is declining (14 units and 3 units in 2014 and 5 and 1, respectively, in 2018) [4]. Similar trends are evident for the Arkhangelsk region where the natural population decline is about 2% annually. Thus, we can talk about negative trends in the development of human capital in the Murmansk region which is one of the most significant areas with an initially high scientific and human potential.

On the other hand, despite the declared innovative way of development, there is a considerable backlog of the Russian Federation in patent activity (especially in high-tech industries), exports and imports of technology in the global market, the volume of science-intensive production and its share in the economy [5-7]. Both in the Russian Federation and in the regions there is stagnation in the scientific and innovative process.

To begin with, the principal characteristic of the innovation economy in contrast to the industrial one is the ability to function in a constant mode of updating traditional industrial structures and established connections, including education systems. This being the case, we should talk about the formation of an institutional environment conducive to scientific and innovation processes in two interrelated areas:

- scientific developments and the creation of new technologies;

- the emergence of business concepts for the commercialization of innovations, the formation of relationships and the use of new opportunities to promote an innovative product.

The development of innovative digital technologies places new requirements not only for the competencies of the future specialists, but in fact requires readiness for continuous qualifications updating. At the same time, new opportunities appear for the human capital development for the regions, enterprises and workers themselves. Thus, according to estimates [8], the digital part of the education market is characterized by stable growth dynamics and by 2023 will be about $ 240 billion with an average annual growth of 17%. For the higher education segment the planned average annual growth in 2017-2021 is 20%. These trends characterize Russia as, for instance, in 2017 in the Russian Federation the average check for distance learning programs in higher education was 42 thousand rubles, for distance learning programs of secondary vocational education - 26.6 thousand rubles.

Thus, the traditional forms of education and the traditional labor market are complemented by networking based on integration and delegation. Digital transformation of the educational space means the formation of knowledge and experience necessary for the implementation of competences in the use of cloud and fog computing tools, advanced analytics as new forms of working with big data, artificial intelligence in accelerated conditions and standardization of basic educational processes [9]. New areas of knowledge covered by digital transformation processes are presented in [10].

Nevertheless, the intensification of interaction between industry, business, education and regional governments is required for the successful formation of a new digital economy. Digital technologies form new opportunities for the development and evaluation of the human capital of the company and the region [11-13].

Experience has shown that the most successful regions in socio-economic development are the ones that actively generate innovations and produce high-tech products. The task of ensuring sustainable regional development aims forming the integrated innovation systems in the regions, combining the potential of leading research and educational organizations (universities) in cooperation with the real economy organizations to ensure world-class competitiveness applied research and commercialization development.

The national implementation project "Science" includes three federal projects:

1. "The development of scientific and research and production cooperation";

2. "Development of an advanced infrastructure for research and development in the Russian Federation";

3. "Development of human resources in research and development.

Key objectives of the national project "Science" are presented in Figure 1.

Fig. 1. Key objectives of the national project "Science"

When developing a project the tasks about science were set that include a set of interrelated goals and objectives. Among these mentioned we note two whose implementation is closely related to the development of digital competencies and the formation of human capital:

-creation of at least 15 world-class scientific and educational centers based on the integration of universities and scientific organizations and their cooperation with organizations operating in the real economy;

- the formation of an integrated system of training and professional growing of scientific and scientific-pedagogical personnel providing the conditions for young scientists to carry out research and development and the creation of scientific laboratories and competitive teams.

The creation of world-class research and education centers (RECs) is aimed at solving breakthrough applied tasks on the priorities of the Scientific and Technological Development Strategy (SITA) necessary for the development of an innovative economy of the country and the training of highly qualified personnel that is capable of participating in solving such problems. Stakeholders and

key tasks of the REC are presented in Fig. 2. The main difference of the REC from the world-class scientific centers (NCMU), as shown in Fig. 2, is the applied nature of the research and cooperation with business structures in order to further commercialize the resulting product including through creating small innovative enterprises.
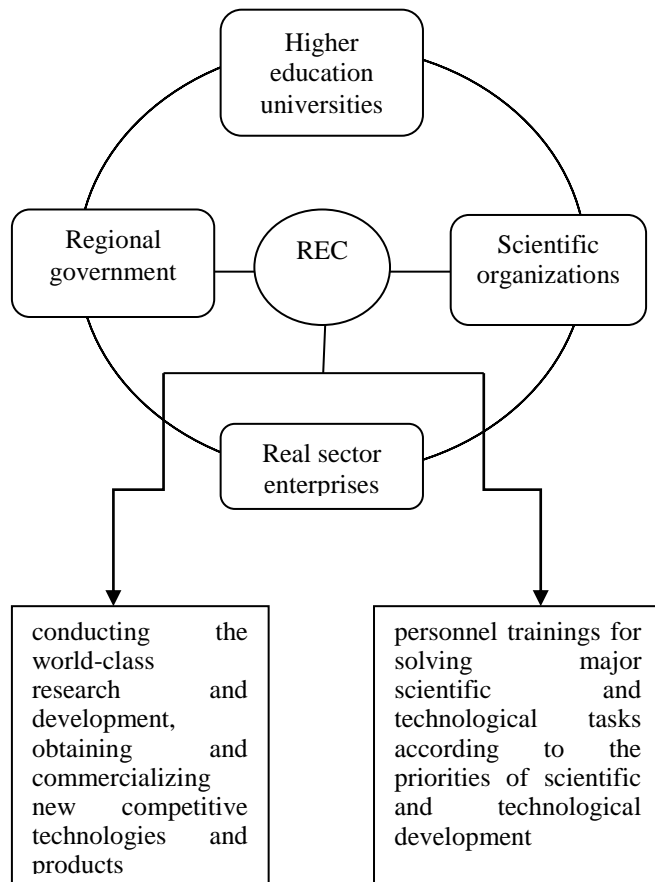

Fig. 2. Key stakeholders of the REC project

REC is supposed to be created on a competitive basis and it can be interregional. At the present stage the resources development of the Arctic poses challenges the use of innovative digital technologies that also requires the development of the technological base as well as the human capital of the region and provide expertise who possess modern digital competencies and are able to use knowledge to solve the unique and non-standard tasks taking into account specifics of the region. Therefore, it was decided to create a world-class Arctic research and development center (REC) which should provide training for solving applied scientific and practical problems of innovative development of the Arctic spaces and resources.

III. SOLUTION TO THE PROBLEM

Significant advantages for the region in which the REC will be located led to the competition between the subjects of the Federation that are fully or partly related to the territories of the Arctic and having high scientific, educational and industrial potential. At the same time the dominant requirement in the competitive selection of a reference region in creating a world class NEC will be how motivated the region is to use and consolidate the efforts of project stakeholders to create effective scientific-educational and scientific and industrial cooperation in order

to conduct world class applied research and development on current trends in the development of the Arctic economy. The result of such scientific and practical developments should be the receipt of new competitive technologies and products with their subsequent commercialization.

The Murmansk and Arkhangelsk regions have significant competitive potential for creating world-class SECs through the following factors:

- on the territory of the Russian Arctic only these two regions in terms of the formed spatial, economic and social framework belong to the territories of industrial development and have prospects for the transition to post-industrial development. The remaining areas are related to active development areas (based on open fields, existing gas pipelines and oil pipelines, sea ports) or prospective development (based on studied fields, formed and developed transport routes), as well as wildlife areas that form the environment for preserving natural space.

- convenient economic and geographical location;

- relatively favorable climatic conditions;

- closeness to Russian scientific and educational centers (St. Petersburg, Moscow) as well as international ones.

The key mechanism for the development of the Russian Arctic consists of three components:

- Availability of *economic and technological development zones* (ETDZ) - integrated projects for planning and ensuring the socio-economic development of the Russian Arctic, aimed at achieving strategic interests and ensuring the national security of the country.

- *The cluster approach* is based on the advanced development of the transport, energy and social framework of the territory and the concentration of resources in priority supporting zones of development and deployment. This is due to the fact that the Russian Arctic requires a fundamentally different quality of transport and energy infrastructure, as well as the social sphere (taking into account the length of the territory and the lack of internal transport links in the region) [10].

- *Selective state policy* in the development of the Russian Arctic means that special approaches should be applied to the implementation of state budget, tax, tariff and social policies, as well as special mechanisms of direct state participation in the development of the economy, including the placement of government orders, the creation and operation of state corporations, economic zones, the distribution of funds of development institutions of the Russian Federation and others [14].

Taking into account the stated criteria, we consider the situation in these areas:

1. The Murmansk region plays a defining role in the realization of Russia's national interests in the Arctic in the areas of socio-economic development, military security, defense and protection of the state border, science and technology, as well as international cooperation [14]. The scientific and technological components of research in the Arctic, the exploring and developing resources on its territory and in the surrounding water areas are mostly

located in the Murmansk region, creating full-fledged regional and industry clusters [14]. Among the strategic advantages of the Murmansk region we note:

- advantageous geographical position (over 14% of the total Russian goods transportation by sea falls on the Murmansk region),

- the availability of significant mineral reserves (the region is the only Russian producer of apatite, nepheline and baddeleyite concentrates as well as high-grade electrolyte cobalt and it provides more than a half of the total Russian nickel production, 10% of the iron ore concentrate and 7% refined copper),

- developed infrastructure that includes directly related to the maritime activities (coastal complex, including port facilities, shipyards, coastal fish processing enterprises, the nuclear fleet and more than 200 sea fishing vessels), that defines the formation of world-class competitiveness level of full-fledged clusters in the region: transport and logistics (service support for navigation along the Northern Sea Route and transport services export), maritime services (service support for the implementation of projects for the development of offshore oil and gas fields in the Russian sector of the Arctic, including the creation of the Center for the construction of large-tonnage offshore facilities "Kola Shipyard" in the Murmansk region), mining and chemical and fishing clusters.

- high scientific and educational potential, the infrastructural core of which is state universities and research institutes: Murmansk State Technical University (MSTU), Murmansk Arctic State University (MASU), institutes of Kola Science Centre of the Russian Academy of Sciences (KSC RAS), Nikolai M. Knipovich Polar Research Institute of Marine Fisheries and Oceanography (Polar Branch of FGBNU "VNIRO").

All of the above contributes to the development of industrial productive and service specialization of the Kola Support Zone in the maritime sector (service support for navigation along the Northern Sea Route and export of transport services, service support for the implementation of projects for the development of offshore oil and gas fields, the fish industry), mining and chemical and oil and gas (the construction of the oil terminal on the west coast of the Kola Bay) directions.

1. The Arkhangelsk region is characterized by structured and formed enough clusters (shipbuilding and timber industry), that have become a source of innovation and competitiveness of the regional economy. Also a large scientific and educational complex of the Northern (Arctic) Federal University named after M.V. Lomonosov (NAFU) was founded in the region, implementing innovative research and educational programs and conducting basic and applied research.

The Arkhangelsk region is directly involved in 6 out of 17 priority projects approved at the government level. The Arkhangelsk region is one of the most developed economic centers of the Russian Arctic, which determines its current and future potential of the reference region for the implementation of large-scale projects for the study and development of the Arctic.

Thus, the Murmansk and Arkhangelsk regions have significant scientific and educational as well as industrial potential to create a world-class REC there.

Despite the fact that the basic principles of requirements placed on RECs are set out in the Russian Federation government-developed methodology of state support for world-class RECs [15], but there is no clear understanding of the very model of creating a center at the moment. The conceptual model of the creation of the Research and Education Center in the Arkhangelsk Region - the "New materials and technologies for the Arctic" REC provides outlook research and development in the new materials and technologies. It is planned to create alliances with leading research centers (SIC) and research and production associations (NGOs) of the key industries: shipbuilding, nuclear, thermal and hydropower, gas and oil refining, engineering and military equipment.

Scientific, educational and industrial potential of the Murmansk region is not taken into account that significantly reduces the efficiency of the center in terms of the final socially significant result. It is important that in the context of the goals and objectives of providing the Arctic economy with advanced scientific research and highly qualified personnel to fully exploit the potential of the Murmansk region that has unique scientific and educational, production-related specifics, including the actual presence of the largest mining and chemical enterprises, metallurgical, marine (fishery) complex, as well as the implementation of the largest Russian companies (Rosneft, Gazprom Neft, NOVATEK) on the territory .These companies that form the paid demand for scientific and practical research and development that corresponds to their needs, the demand for personnel, technology and equipment, and which are potential REC participants as industrial partners.

The integration model of forming a world-class Arctic Scientific-Educational Center is based on the principles of a convergent-network approach of interregional interaction when participants within a single system "science - education - production" are connected by integration relations to maximize the use of scientific, industrial, human potentials. In this case, participants are guided by common long-term goals. A key aspect of scientific, practical and educational cooperation is the application of the principles of convergent technologies that makes full use of the interdisciplinarity of research and the intellectual and scientific and educational potential of all REC participants.

In modern understanding, convergent technologies can be characterized from an interdisciplinary approach point of view, as an interpenetration of nano-, bio-, informational and cognitive sciences and technologies, the result of which is a multiplicative (synergistic) effect that can bring the socio-economic system to a qualitatively new technological level. As the key principles for the development of convergent technologies, it is possible to identify:

- compliance with the global strategic goals of state policy in the science and technology and focus on solving the problems of structural transformations of the economy, ensuring safe and sustainable socio-economic development;

- inadmissibility of information asymmetry between

participants in the process of convergent technology development;

- concentration on the so-called "critical" technologies that ensure the technological independence of the country;

- taking into account the interests of all actors involved in the development of convergent technologies: educational, research, design and engineering institutions, industrial enterprises, the final consumer [16].

This approach is designed to combine the scientific and human capital of the regions, and ensure the concentration of resources in the area. This is a priority and has practical importance for the needs of the Arctic economy real sector. The complexity of the approach will allow eliminating the unpromising areas of development that do not have the potential for commercialization. This is especially important in today's market conditions.

An interregional integration model can cover a complete innovation cycle: "applied research (technological solutions) - pilot production (prototype) - small-scale production - mass production - market realization". Such interaction on the basis of the strategic partnership of all the convergent network structure participants of the interregional REC will provide leadership research and development. As well as a comprehensive solution of problems based on the systemic interaction of the participants, including through the introduction of modern digital and information and communication technologies. Fig. 3 shows the target model for the creation of an Arctic world-class Research and Education Center in a dual-core (hybrid) model of interregional integration based on the principles of interregional convergent-network interaction.

Highlight the main advantages of a systematic approach:

- the actors of the REC network are sharing advanced experience and scientific achievements (knowledge) in the subject area. The use of network technologies can provide a continuous exchange of experience and joint problem solving.

- ensuring a high level of informatization and standardization of the innovation cycle processes will make the network structure adapted to the constantly changing requirements of the external environment;

- continuous exchange of information and interaction of network participants both within the network structure and with end-users;

- convergent-network association will allow to accumulate the human and infrastructural potential of the participants (residents) of the REC for solving agreed targets of scientific and technological development;

- focus on long-term cooperation, the development of joint innovation development programs encourages effective interaction for all residents of the integrated network of REC participants;

- increasing the companies competitiveness in the real economy - residents of RECs by developing their core competencies and finding;

- market niches across a wide range of industries where competencies can be realized (innovation transfer) ;
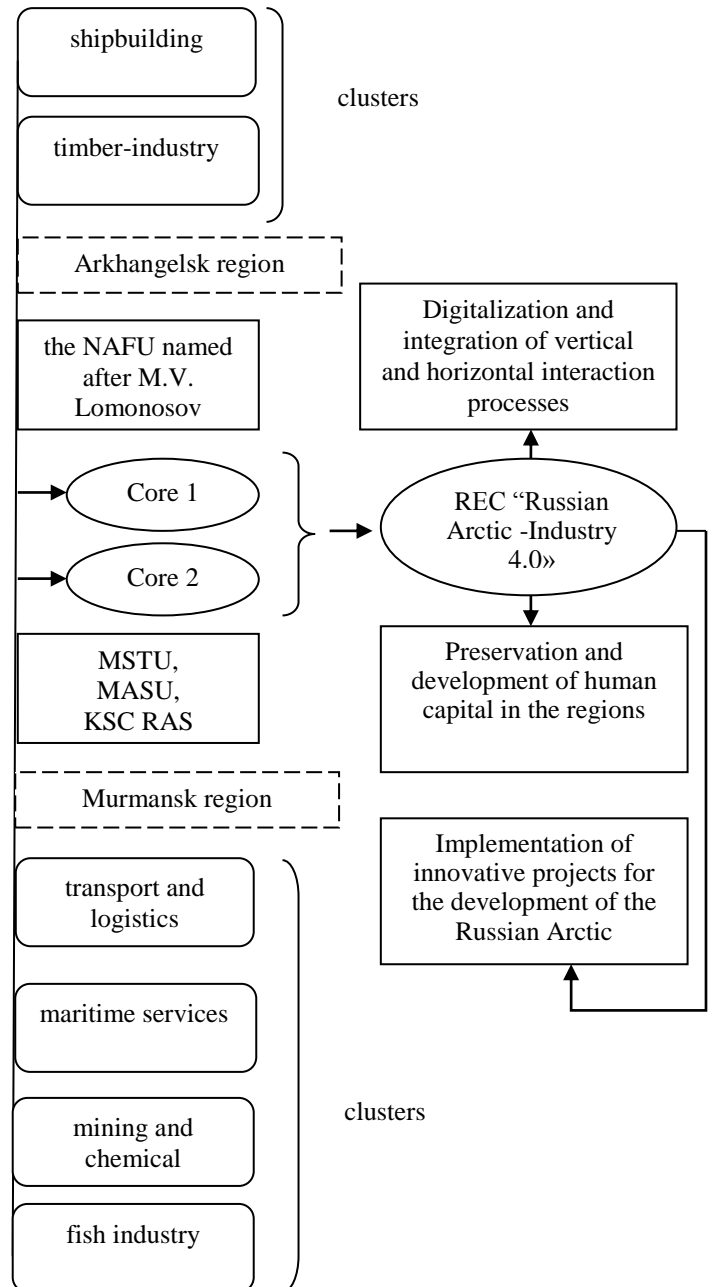

Fig.3 Dual-core converged network model of creating a world class "Russian Arctic-Industry 4.0" REC

- achieving leadership positions in research and development in priority areas of scientific and technological development, integrated solution of specific applied problems of ensuring competitiveness in the modern economy, including through the introduction of digital and information and communication technologies.

IV. DISCUSSION

It should be taken into account that the achievement of the objectives of Russia's state policy in the Arctic will take place under conditions of the fourth industrial revolution. Therefore, the process of industrialization of the Arctic economy that combines technical-technological and socio-ecological modernization is initially necessary and possible to form on digital production technologies that are the essence of "Industry 4.0" and convergent technologies that

can be described as interpenetration of nano-, bio-, information and cognitive sciences and technologies. The result should be a multiplicative (synergistic) effect that can bring the socio-economic system to a qualitatively new technical and technological level. At the same time, the achievement of the goals is impossible without the growth of the quality of human capital in the region. This is the dynamic that determines the target model for the formation of a world-class research and education center - SEC "Russian Arctic - Industry 4.0".

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