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The International Arctic Consortium Model

E A Afonichkina¹, A I Afonichkin², M M Stepanova¹ and E U Tokareva¹

¹Peter the Great St. Petersburg Polytechnic University, St.Petersburg, Russia

²Samara National Research University, Russia

ekaterinaafonichkina@gmail.com

Abstract. The study considers economic development of the Arctic region as supported by innovations and sustainable technologies, compliant to environmental regulations and following the trends of the Arctic region sustainable development. The experience shows that only joint efforts of researchers from different countries and the concentration of their research and investment potential can lead to positive results for each country, and ensure a positive effect for all cooperating countries, as well. A model of the International Arctic Consortium has been proposed. The Consortium operates on the basis of coordinated interests of the participating countries and ensures the development of the Arctic territories of the circumpolar countries.

1. Introduction

The modern development of the Arctic economic space requires a thought-out strategic development vector that takes into account the risks associated with the process of economic development of the northern territories, environmental protection, and the development of social policy for the indigenous population of these territories.

The northern territories are least developed and their territorial units cannot finance the necessary socially and technologically significant and expensive projects aimed at the development of the North, including the development of environmental and territorial social projects (medicine and health care, schools, kindergartens, roads and transport). The existing experience in the development of the Arctic Circumpolar Territories shows that creating the necessary infrastructure is very expensive and many of the problems of Arctic development require the cooperation of interested countries and organizations, both in terms of providing resources and financing Arctic projects. Only joint research and the concentration of the scientific and investment potential can lead to positive results, both for each country and for all cooperating countries as a whole. However, despite the existence of international collaboration in this area, the economic prospects are still not taken into account, although the result could have a huge potential for Arctic economic development. This is due to the existence of conflicting interests between the countries aspiring to develop the Arctic territory.

The development of the Arctic, as well as the development of the constituent entities of the Russian Federation in the industrial development of the Arctic territories, requires the solution of many complex problems, including the development of new highly efficient technologies for resource extraction and processing, better organization of production activities, transportation, logistics, international environmental safety standards, socialization of indigenous peoples, and much more.

2. Arctic development problems



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An important problem in the development of the Arctic territories is compliance with the international convention for their environment protection (United Nations Convention on the Law of the Sea) . Article 234 of the Convention [1] provides for the right of States “... to adopt and enforce non-discriminatory laws and regulations for the prevention, reduction and control of marine pollution from vessels in ice-covered areas within the limits of the exclusive economic zone, where particularly severe climatic conditions ... could cause major harm to or irreversible disturbance of the ecological balance”.

However, climate warming and the reduction of sea ice cover provide more open sea access to the Arctic and increase the navigation period, which increases interest in the Arctic, as there are enormous reserves of oil, natural gas and mineral resources [2]. Still, such spatial changes can create significant problems in the form of accelerated coastal erosion and more intense pollution of the marine and air environment. Changes in permafrost conditions can exacerbate existing permafrost and lead to new environmental problems. These are both man-made accidents and violations of infrastructure operation conditions (destruction of pipelines, water intake and water treatment facilities). Thus, against the background of warming, extreme weather events appear, the ice thickness decreases and the Arctic ice area decreases [3]. This reflects the complexity and ambiguity of the possible consequences, including for the population and the economy. Such natural factors can lead not only to increased threat to human life, but also to the habitat of some species of fauna, the reduction, disappearance, migration of existing species of plant and living organisms, the invasion of new species of microorganisms [4].

For example, the activities of Sweden, Norway, Iceland, Denmark, Finland and Canada are aimed at minimizing the negative effects of expected climate change and are related to the analysis of the vulnerability of economic sectors, ecosystems and population. The experience of these countries can be used for international cooperation in the field of environmental monitoring. Assessment of environmental risks and changes in the ice situation in the Arctic within the framework of the assessment of opportunities for the oil and gas industry, shipping, public health, etc. are considered in works [5, 6, 7]. Expansion of international cooperation in the field of adaptation to global climate change will contribute to minimizing the negative consequences of natural and man-made disasters.

Thus, it is proposed to establish the international Arctic Consortium (AC) for the joint activities of heterogeneous organizations for the development of the Arctic territories. The Consortium will operate on the basis of coordinated interests of the participating countries and ensure the development of the Arctic territories of the circumpolar countries. It is also necessary to take into account the consistency of actions and intentions of the participating countries in the following areas:

- economic development
- ensuring sustainable development of the Arctic territories
- environmental coordination of projects and activities
- information support for Arctic development projects and climate dynamics
- social equalization of indigenous peoples' lives and the maintenance of peoples' identities
- development of innovative technologies in production, processing and transportation of products
- ensuring social conditions for working people and adequate incentives for their activities
- solution of waste recycling tasks, etc.

3. International Arctic Systems Management Model (two-level system)

Considering a certain international consortium (system) in a generalized form, which solves the spectrum of problems of development of the international Arctic territory, it is possible to formally present such a system in the form of a simplified structure with a single management center and elements of the system that have their own activity and independent resource potential. Such a system has common global objectives, but each element of the structure (the active element) also has its own objectives. The efficient operation of the entire system is possible under the following conditions:

- coordination of interaction on the basis of material criteria of activity
- availability of an adequate level of overall resources, at least critical
- availability of open information exchange on development projects and activities

- balance of interests in the common system.

Let us consider a formal model of such an international Arctic consortium in a generalized form with the possibility of dynamic expansion of the number of participants.

To do this, the following symbols are used:

$S_0 = \{a_1, a_2, \dots, a_n\}$ is the initial composition of active elements (AEs) of the Arctic Consortium (AC), consisting of n participants, $|S_0| = n > 1$.

S^N_C is the final composition of the AC after N periods of activity.

A is a set of potential AC participants applying for membership in the AC.

The following conditions are met:

1. $S_0 \subseteq S^N_C \subseteq A$,
2. $P(S_0) > P_{SD}$, where $P(S_0)$ is development potential of the international Arctic Consortium within the global common goals, P_{SD} is the critical value of the strategic development potential required for the implementation of consortium development projects as a whole.

For each AE, there is an additional level of development potential to achieve its own goals, $P_d(S_0)$, then

3. $U(P(S_0), P_d(S_0)) = (P \cup P_d)(S_0) \mid (C_{AK} \cap C_{A\Delta})$, where C_{AK} are the global goals of the Arctic cluster as a whole, $C_{A\Delta}$ are the goals of a specific active element a_j , $a_j \in AK$. You can also set the efficiency function of the entire system (AK) as a whole to Ψ_{AK} ,

4. $\Psi_{AK}(S_0, S_C, A, P, \{P_d\}, C_{AK}, \{C_{A\Delta}\}, W, \{\Psi_{aj}\}, \Delta\varphi)$, and each individual tap target a_j , Ψ_{aj}

5. $\Psi_{aj}(S_0, P, \{P_d\}, C_{AK}, \{C_{A\Delta}\}, W, \varphi((C_{AK})\bar{R}(\{C_{A\Delta}\})))$.

And

$\Psi_{AK} = \langle \{U \Psi_{aj}\}, P, W, \Delta\varphi \rangle$, where W is the external environment, $\Delta\varphi$ - additional effect of the activities of the joint cooperation of the AE among themselves, $\varphi((C_{AK})\bar{R}(\{C_{A\Delta}\}))$ - Function of effect (risk) in case of possible interaction of global and local interests in the activities of nuclear power plants. At the same time, the task of managing such a consortium (AC) is to form a consortium management center and such a policy or strategy of AC development management that will ensure maximum efficiency of activities.

Thus, it can be determined that such a consortium belongs to the type of complex (large) economic systems with a dedicated corporate governance center. And for such systems it is possible to define the guaranteed value of the target function (C_{AC}) of the corporate development management process on the set of corporate participants (n). In the structure S_0 of AC there is a leading corporate governance center (a^U), which forms the development strategies of AC $AK \{F^d_j\} \subseteq a^U, D^P \rightarrow \{F^d_j\}$ where $\{F^d_j\}$ is a set of possible development strategies of AC, D^P is AC development policy.

In this case, the task of managing the Arctic Consortium can be formulated as the task of finding an acceptable vector of AC development management, reflecting possible development strategies $\{F^d_j\}$, for which the efficiency of development management processes (Ψ_{AC}) would be maximal,

$$\Psi_{AK} = \langle \{U \Psi_{aj}\}, P, W, \Delta\varphi \rangle \rightarrow \max \quad (1)$$

with restrictions on:

- AE operating activities (V_1, V_2, \dots, V_m) $\in S_C$;
- composition of the final structure of the AC ($S_C, \Psi_{AK}, \Psi_{aj}$);
- level of system-wide economic development potential ($P(S_0) \geq P_{SD}$).

At the same time, we believe that each potential active element $a_i \in S_C$ possesses financial, informational, human and material capital, competences, which actually defines the economic potential of the economic system development. Each AE has some limited operational capacity to participate in system-wide activities and has rights to results. Thus, in the structure of the AC, several operational business chains for the creation of system-wide values are formed, the rights to which are distributed and assessed by the corporate management center (a^d). Such a center forms the management policy and strategies, sets the structure of business chains in the corporate structure and centralizes the development management process, distributing management functions among the nuclear power plants in accordance with the adopted policy taking into account the existing restrictions. The development management policy should reflect the following conditions:

- the existence of common development goals;
- the corporate participant's subordination of its objectives to those of a system-wide nature;
- coordination of management and production processes in the value chains;
- possibility of integrating development resources (potential);
- balance of interests of corporate participants between themselves and the management center.

In the process of AC development management it is supposed to be possible to change the composition and structure of EC participants, to strengthen the development potential, to propose new global goals and directions in the structure interrelationships. While these issues are also important in assessing the effectiveness of international organizations, we will not address them here yet. We will assume that such changes will be implemented as the relevant active ingredient strategies or system-wide policies change.

4. Three-Level System Model (with local national control centers)

In the previous section the generalized AC model is presented and described in the form of a two-tier system with one control center and a group of AEs involved in the operation of the AC. However, participation in international corporate systems shows the existence of intermediate management centers that coordinate the operational activities of national participants (AE). The management and coordination functions of such centers are not equal to those of the head office, but their impact on the functioning of the national AE group should be taken into account.

In this section we will consider the structural type of AC, consisting of n participants, where participants are grouped according to nationality and such groups k . $S_{0N} = \{(a_1, a_2, \dots, a_f)_1, (a_{f+1}, a_{f+2}, \dots, a_h)_2, \dots, (a_{h+1}, a_{h+2}, \dots, a_n)_k\}$ - the initial composition of the active elements of the AK Arctic Consortium consisting of k national groups with a total number of participants n , $|S_{0N}| = n > 1$; $k > 1$. A local management center is responsible for the management and coordination of each designated national team of active elements. In the structure of AC there are k - local control centers (possibly with different coordination functions) $\alpha^1 \subseteq (a^1_1, a^1_2, \dots, a^1_m)$, $\alpha^2 \subseteq (a^2_1, a^2_2, \dots, a^2_h)$, ..., $\alpha^k \subseteq (a^k_1, a^k_2, \dots, a^k_z)$. Then the structure of AK has the form shown in Fig. 1.

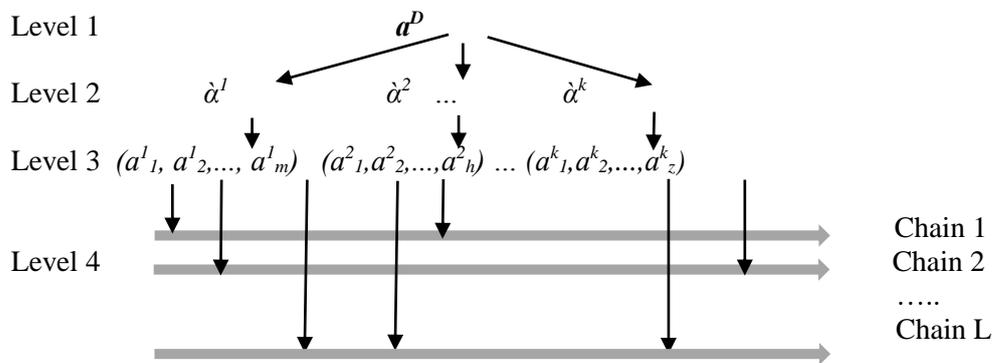


Figure 1: Model of the structure of an international Arctic concern with national management centers (level 2)

Level 1 is the AK's main management center. Level 2 reflects the national local management centres that regulate part of the activities related to the national competencies of the active elements. Level 3 - national groups of active elements implementing operational activities taking into account the systemic interests of the AC, national interests and own interests of the active element. Level 4 is a system of operating chains in which the active elements themselves, belonging to different national groups, perform activities.

In this case, the value chains are defined as joint operational actions to form individual projects. In particular, in the Arctic cluster these may be social projects aimed at improving the lives of indigenous peoples, projects to develop transport infrastructure (Northern Sea Route, air, railway, etc.), projects to

monitor the environmental situation, the climate in the Arctic, projects for mining and processing of minerals, etc.

The principal difference between corporate structures with several management centers, although at different levels, is that, in contrast to the economic system (ES) with a single center, in the economic system with several centers there are problems of interaction between the centers, which affect the efficiency of the participants. Therefore, in addition to finding optimal stimulation functions for the participants, there is a need to solve additional tasks to identify the principles and forms of coordination of activities in order to achieve equilibrium states of the ES structure under various development management strategies. Such a requirement for international structures with particularly sensitive governance parameters, like those for the Arctic Consortium, provides a balanced strategy for national governance centers so that none of them would benefit from changing their strategy from one that is balanced to another. As part of this requirement, in addition to the AC development strategy, it is necessary to formulate an effective function of corporate incentives for long-term activities of the Arctic Consortium.

5. The Corporate Structure of the Arctic Consortium Model

Let us consider a simple consortium model in the form of a hierarchical two-level structure, $n \geq 1$. a_k is a consortium with one independent control center (CC), for which the target function of development is known in the form of some efficiency criterion. The $H(x)$ yield criterion, as it is accepted in the theory of active systems, in this case is not the main and immediate one, but is characterized as a deferred efficiency criterion for the time T .

The target C_{AC} function thus corresponds to the AC efficiency function, Ψ_{AC} , which reaches its maximum when the target function is executed under limit conditions, i.e. $\Psi_{AC} = \psi(C_{AC})$.

In addition to operational and resource constraints, there are problems in the interaction of consortium agents, and it is necessary to take into account the methods and intensity of interaction. For example, a typical consortium, the Barents/Euro-Arctic Council, has a relationship that informs and prescribes specific activities. Norway and Russia initiated the establishment of a cooperation organization in the Barents Sea Arctic region. On March 8, 1992 in Oslo, the Ministers of Foreign Affairs of Russia and Norway signed a joint protocol on the working program of contacts and cooperation between the northern regions of both countries. The concept of cooperation between the Barents Sea territories was formulated in the 1993 Kirkenes Declaration. The main organizations within which the Barents Euro-Arctic cooperation takes place are the Barents Euro-Arctic Council (BEAC) and the Barents Regional Council (BRC). It includes Denmark, Finland, Iceland, Norway, the Russian Federation and Sweden as permanent members, as well as the European Commission. Nine countries (the United Kingdom, Germany, Italy, Canada, Japan, the Netherlands, Poland, France, the United States) have the observer status.

Cooperation between the territories in the Barents region is two-tier in nature. The first level of cooperation is carried out in the framework of BEAC, in the framework of an intergovernmental cooperation forum. The second level of cooperation is carried out within the framework of the BRC, in which 13 regions of the member states participate, and is interregional in nature. The purpose of BEAC is to promote sustainable development of the region, bilateral and multilateral cooperation in the fields of economy, trade, science and technology, environment, infrastructure, education and cultural exchange, tourism, as well as projects aimed at improving the situation of indigenous peoples of the North.

As we have already defined, the peculiarity of such multilevel systems with distributed national centers is the possibility and necessity of complex interactions on many vectors of interaction between themselves, with centers, environment, etc. Thus, in the structure of interactions it is possible to highlight the following relations: - financial, - material, - efficiency, - information integration, - monitoring of the Arctic phenomena, - material production, - transport support, etc.

To display the system of interaction of active elements at operational activity, we will designate as: $\{R^{a_{ij}}\}$ is a set of different types of interactions between agents; $\{R^{a^U_i}\}$ is a set of different types of

interactions between agents and the control center; $\{RaUi\}$ is a set of different types of interactions of the control center with agents; $\{R^{Ua}_i\}$ is a set of different types of interactions of agents with external participants in the process of operational and investment activity; $\{R^{UX}_{ij}\}$ is a set of different types of interactions of the control center with external participants in the process of operational and investment activity. Then, let us define the set of different types of interactions of AC participants as $(\{R^{a}_{ij}\}, \{R^{aU}_i\}, \{R^{Ua}_i\}, \{R^{ax}_{ij}\}, \{R^{UX}_{ij}\}) \in \llbracket \check{R} \rrbracket$

Taking into account the existing and possible level and types of economic potential of AC development at the disposal of each AE, and their interaction in achieving the target function, it is possible to set the vector of strategic development in the form of a system of strategies.

$\{S\} = (\llbracket \check{R} \rrbracket, P, W, C_{AC})$, however considering that $P = P_{AC} = \bigcup_{i=1}^m P_{A\exists} + \Delta P_{AC}$, where ΔP_{AC} is the potential of the AA system itself, or $\{S\} = (\llbracket \check{R} \rrbracket, (\bigcup_{i=1}^m P_{A\exists} + \Delta P_{AC}), W, (C_{AC}/C_{AE}))$, where the expression (C_{AC}/C_{AE}) denotes the achievement of the AC goals through the implementation of the development strategy, taking into account the possible agreement with the private goals of the active elements of the consortium.

When defining the target function of AC development (1), it is desirable to present it in the form of a calculated profitability criterion $N(x)$, which is formed by AC in interaction with the system assets and system agents (participants) (a_{ij}) ,

$$H(A) : \{S_{ij}\} \rightarrow \{\Psi_{AC}^p\}, \quad (2)$$

where $H(A)$ is a function of the income of the system's activities, depending on the actions and interactions $\llbracket \check{R} \rrbracket$ $a_{ij} \in A$ agents, i.e. activities carried out by the whole system.

It is necessary to note the following condition that the function of income $H(A)$ is a function deferred in time, i.e. the maximum return value should be formed not at the moment of observation t_0 , but after a certain period of time $T = t_0 + \Delta T$ in the form of a deferred investment wave. In the simplest case, the deferred function of $NT(A)$ income can be formulated as a discounted value through

$$H^T(A) = H(A) (1 + r)^n \quad (3)$$

Then we transform expression (2) taking into account (3) and present it as $H^T(A) : \{S_{ij}\} \rightarrow \{\{U_{aj}\}, P, W, \Delta\varphi\} (1 + r)^n$, or, applying the function of income, we get

$$H^T(A) : \{S_{ij}\} \rightarrow \{(\sum_{i=1}^n \sum_{j=1}^k H^T(a_{ij})), \llbracket \check{R} \rrbracket, P, W, \Delta\varphi\} (1 + r)^n \quad (4)$$

Considering in more detail the forth level of the AC model, it is necessary to evaluate the strategies of operational and development activities of AC active elements. In this case, we mean that, in the process of interactions of agents $(a_1, a_2, \dots, a_j, \dots, a_n)$, $(a_i \{R\} a_j)$ in value chains, each of the agents applies a pre-coordinated strategy $s(a_j)$, which does not contradict the systemwide (s^o) , $(s(a_j) \in s^o) \subset \{S\}$.

6. Conclusion

Thus, the paper presents the corporate type models of the Arctic Consortium, which may be required in terms of conditions and limitations of activities in the Arctic territories for the two- and three-level system with national control centers.

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