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COMMUNICATION ASPECTS OF TECHNOLOGICAL DEVELOPMENT ECOSYSTEM MACROREGION

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Abstract

Macroregion - the Arctic is a tracked area, the technical development of which is rapidly growing, unsystematically and without methodological approaches. The main focus of Arctic development is on the development of natural resources, the construction of infrastructure and adaptation to difficult natural conditions. The main directions of improving the environmental situation are the improvement of technologies for the exploitation of natural resources, the construction of treatment facilities at plants and factories, the creation of reserves and wildlife preserves. For both economic and environmental well-being, the level of technological development is important. Many factors and conditions must be taken into account for the successful functioning and development of the macroregion's technological ecosystem. In this study, we highlight the communication aspect in the subject and object categories, which are explained by the ongoing digital transformation of the environment, on the one hand, and by the importance of this aspect in the functioning and development of the ecosystem on the other hand. Concerning the technological development of the macroregion ecosystem, we are talking about the formation of a strategy for the technological connectivity of all its elements, taking into account social, economic and environmental factors. The communication aspect determines, on the one hand, the efficiency of technological connectivity and on the other hand, provides diffusion of technologies.

Keywords: Macroregion development, sustainable development of the Arctic territories, technological ecosystem.

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1. Introduction

Technological development in modern conditions determines the main trends in the development of the economy. At the same time, the development of scientific and technological progress is systematic and meets certain economic conditions. This dualism is the basis of the theory of technological ways. According to the concept of sustainable development, it is important to take into account not only the economic efficiency of technological development but also its impact on society and the environment.

The main goal of this study is to form a conceptual model of technological development of the macroregion using the example of the Arctic macroregion.

To achieve this goal, we used various theories of technological and innovative development. It is proposed to solve the existing problems in the development of the macroregion based on the ecosystem approach.

2. Problem Statement

We see methodological problems in using existing theories of ecosystem development.

Approaches to developing methodological recommendations for ecosystem management at different levels are based on concepts of technological connectivity and diversification of local knowledge with the justification of alternative technological trajectories (Balland et al., 2019) and the justification of an uncertain mechanism for managing macroregions (soft spaces) in the form of cooperation of regions in a certain territory for joint development (Sielker & Rauhut, 2018). Domestic authors emphasize the strategic direction of the region's development and the great importance of digitalization of the economy and the introduction of smart technologies in the management of the region (Fraimovich et al., 2020).

Technological ecosystems have been little studied, there is no methodological base, theoretical studies are scattered and not systematized. Most studies consider innovative ecosystems, for example, the concept of a "triple spiral" (Leydesdorff & Zawdie, 2010), open innovation models (Appleyard & Chesbrough, 2017; Teece, 2014), food innovation ecosystems (Dachs et al., 2017).

Regarding the innovation ecosystem, most theoretical studies consider the macro-region of the Far East, with emphasis on the development of innovative entrepreneurship. The Arctic zone is not being studied so actively, research concerns the theory of open innovation and to a lesser extent technical development (Shaslo et al., 2018).

Russell et al. (2011) defined the innovation ecosystem as a complex of political, economic, technological and environmental systems that are directly involved in creating, maintaining and developing a favourable environment for business development.

The authors note that the ecosystem is interconnected with entrepreneurship: as an ecosystem approach through which entrepreneurship develops, for example, Stam (2017), and determining the impact of entrepreneurship on the formation of economic, technological and social thinking in its ecosystem (Audretsch et al., 2019).

This logically leads to the priority of the ecosystem-based approach in the economy, whichmeans the integration of environmental, economic and social principles of the management of different systems.

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In our current view, the ecosystem-based approach is being updated for the macroregion because, firstly, it corresponds to anti-globalization trends; secondly, at the level of the macroregion, it is possible to make full use of systemic analysis, clarifying the specifics of its technological development, taking into account social and environmental factors. This is especially relevant for the ecosystem of the Arctic macroregion.

Many factors and conditions must be taken into account for the successful development of the macroregion's technological ecosystem. In this study, we highlight the communication aspect in the subject and object categories, which are due to the ongoing digital transformation of the environment on the one hand, and to the importance of this aspect in the functioning and development of the ecosystem on the other hand. About the technological development of the macroregion ecosystem, it was a matter of forming a strategy for the technological connectivity of all its elements, taking into account social, economic and environmental factors. The communication aspect determines, on the one hand, the efficiency of technological connectivity, and on the other hand, provides diffusion of technologies.

We used the theory of open Innovation Chesbrough (2003) and its further development and modelling (Chesbrough, 2006), theory of diffusion of innovations by Rogers (2003) and Hägerstrand (1967), theory of industrial revolution Schwab (2017) as the basis of the strategy of technological connectivity.

Hägerstrand built the first theoretical model for the diffusion of innovations, including technological ones, with a simulation approach using such concepts as distance, field, contact, information. These concepts characterize the macroregion quite well. The main patterns of diffusion of Hägerstrand technologies and comments on applicability to the development of the macroregion ecosystem in the communication aspect are as follows:

1. In the absence of restrictions on the transmission of innovation, the diffusion process develops in an "explosive" way. At the same time, the number of innovators doubles at each stage. This requires building technology chains with effective communications and sound public policies.
2. The process of diffusion of innovations ceases more abruptly than it develops, which makes it possible to regulate effective communications.
3. Central innovators have the maximum opportunity for technology transfer. In each macroregion, such participants may be different, for example, for the Arctic macroregion where northern sea route forms the structure.
4. Innovators located on the periphery have minimal opportunity for technology transfer. The multiplication effect decreases as you move away from the macroregion. This is included in the cost of efficient communications.

The Hägerstrand model applied to the strategy for technological development of the macroregion ecosystem because:

1. It takes into account the six main elements of the technology diffusion process: the area in which the diffusion takes place; the time during which the process takes place (the time of implementation of strategies and projects); the source of innovation (problems to be solved, which is specific for each region); innovation (technical and technological solutions adapted to the macroregion); acceptors (industrial companies involved in macroregional projects, both within and

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outside the macroregion (research and project organizations, for example); the movement path (within macroregion).

2. The macroregion in which the diffusion process develops has certain characteristics graphically displayed by a fine mesh with one recipient in each cell

3. A period is defined for the transfer of innovations to the recipient, with only one transfer in one period.

4. One cell corresponds to one source of innovation, this cell is defined as the centre.

5. The recipient should become a source of innovation in the next period, while innovation should be transmitted smoothly

6. It is for this reason (transformation of the recipient into a source of innovation) that the recipients are distributed evenly across the macroregion.

7. The novation path is randomly selected by the innovation source towards any of the adjacent cells (i.e. implemented in a contact manner). Innovation cannot jump through neighbouring cells

8. The process of diffusion of innovations ceases when all acceptors within the territory perceived innovation.

Factors of specificity of the Hägerstrand model are the heterogeneity of territories (development, mentality); time intervals (seasonal changes in demand) different concentrations of innovators and acceptors; recipient response to innovation, trends in the transfer of innovation, composition and structure of the transfer of innovation, time-personal border and barrier situations (Rogers, 2003).

To justify the technological development of the macroregion ecosystem, the Hägerstrand model needs to be adapted to the peculiarities of the technological development of the macroregion, taking suitable elements from Rogers's theory. The optimal in our opinion is the rationale for the influence of the social aspects of the technological development of the macroregion ecosystem - for example, E. Rodgers defines the second diffusion through the spread of innovation among members of a certain social environment.

In Rogers theory, one of the main factors in the diffusion of innovation is the time indicator. Firstly, because it is the time for deciding on innovation, which Rogers divides into five stages: from learning about innovation to deciding whether to use it or not. Secondly, the time factor is involved in the process of perceiving innovation by members of the social system (Deart &Tsym, 2016). Also, the time indicator is used to calculate the speed of innovation (the number of innovators at the current time). The last two points are closely related to the communication aspect.

For the macroregion's technological ecosystem to develop, conditions for technology transfer are necessary, both within the macroregion and from the outside environment. This can be taken into account if you use the open innovation of Chesbrough (2003). According to the model, the free transfer of innovation from one area to another accelerates the development of all areas, as technology recipients promote them by building the infrastructure of that technology and developing all stakeholders in the industry, including the market. Also, this reduces the level of costs, which affects the price characteristics and increases customer loyalty (Vetrova, 2019), which corresponds to the concept of "Creating Common Values" (Melnikova, 2019).

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Diffusion of technologies can be described by the logistics function (Akaev & Turduev, 2010). When saturation occurs (the last section of the logistic curve), it is necessary to have a new technology, the distribution of which goes to the stage of intensive growth. This avoids technology gaps and contributes to the sustainability of technological development. Technology change needs a communication dimension.

The further development of innovation diffusion theories is presented in the works of Klaus Schwab, who writes about the transformation of industrial development and society based on artificial intelligence, blockchain, nano- and biotech (Schwab, 2017).

The most complete analysis of Chesbrough's work was made by Trifilova (2008), who writes that based on combining the efforts of universities, national laboratories, suppliers, consumers, industry consortia technology diffusion occurs. It is they who are acceptors according to the model of T. Hägerstrand.

To the above theories, the concept of sustainable development should be added, as, in addition to the above, this concept takes into account the environmental aspect relevant to the technological development of the macroregion ecosystem.

Thus, the construction of a model of technological development ecosystem of the macroregion is based on a set of theoretical models using the communication aspect. In addition, we used the results of our own research in the development of regional ecosystems (Khakimova et al., 2019).

3. Research Questions

Our review of methodological problems made it possible to formulate the following research questions:

1) What lies at the focus of the strategy of technological connectivity?

2) What is the relationship between ecosystem participants?

3) What are the features of the communicative aspect for the ecosystem of the macroregion?

Responding to questions, we concluded that every macro-region will have the original ecosystem. At the focus of this ecosystem should be based on the main technological chain. The participants in this chain are also specific and must be represented by the full cycle of expanded reproduction. The participants in the technological chain form a network. Thus, the strategy for the development of the ecosystem of the macroregion is the strategy of the technological connectivity of the cells of the network of the technological chain.

4. Purpose of the Study

The main purpose of this study is to form a conceptual model of technological development of the macroregion using the example of the Arctic macroregion. Thus, the construction of a model of technological development of the macroregion is based on a set of theoretical models using the communication aspect.

To achieve the purpose we have selected some of the theory and methods applicable to the development of technological connectedness strategy for the macro-region. In this case, the main criterion

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for the construction of the model is the applicability of the ecosystem approach. The specificity of macroregions in Russia is high, so we built the conceptual model using the example of the Arctic macroregion.

5. Research Methods

The construction of a conceptual model of technological development ecosystem of the macroregion is based on a set of theoretical models using the communication aspect. We have built a conceptual model of the technological development of the ecosystem, using the strategy of technological connectivity, based on the synthesis of the theories of technological and innovative development described in this work and focused on the communication aspect and ecosystem management. For model validation, we used statistical methods of research and the methodology of strategic analysis.

We will consider a model of technological development of the macroregion ecosystem based on the Arctic macroregion of the Russian Federation, which includes several regions (Karlik & Platonov, 2017). To build a model of technological development of the macroregion ecosystem, it was necessary to determine the basis around which processes of the sustainable development model were formed, establish communication among participants based on technological chains, and combine chains into networks that acted as means of transferring innovations and technologies. The timing of the project and the value-added it creates are optimization criteria.

In particular, for the Arctic macroregion, it is proposed to consider the Northern Sea Route, which creates value-added through transportation, as the basis for the model of technological development (table 1).

Table 01. Commissioning of production facilities and facilities on the land territories of the Arctic zone of the Russian Federation in 2019

Heading level	Unit of measurement	Total through construction and reconstruction
Sewerage networks to production facilities	km	4,1
Power lines up to 35 kV	km	155,7
Transformer lowering substations up to 35 kV	thousand kVA	79,8
Antenna-mast structure of digital terrestrial broadcasting	PCS	3
Diesel power plants in the Far North	thousand kW	3,1
35 kV and above transmission lines	km	218,0
Ship Repair Plants	RUB million	289,8
Transformer lowering substations with a voltage of 35 kV and higher	thousand kVA	51,3
Oil wells, total	units	474
Production Drilling Gas Wells	units	93
Gas pipelines and branches from them	km	187,1
Seaport berths (including seaport transhipment complexes)	linear meter	772,0
Oil pipelines trunk and oil product pipelines trunk regional	km	3,9

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6. Findings

Chains and communication networks were being built around it to ensure increased value. This requires solving some related problems in various areas of activity, mainly in industry. For example, in shipbuilding and shipping - this is the supplying of vehicles - icebreakers and other vessels, clarification of the water area and traffic routes, the development of port infrastructure, etc. That requires technologically related solutions in various sectors of the economy that take into account the characteristics of the Arctic macroregion. Participants in the chains form along the NSR to the principle of technological connectivity and create their value-added. Also, several types of activities can be carried out remotely not in the Arctic territories, in particular research, design, etc. (Figure 01).

The authors believe that the formation of technological chains, and, consequently, a strategy of technological connectivity, requires resources, centres of responsibility in the links of the technological chain and sustainable channels.

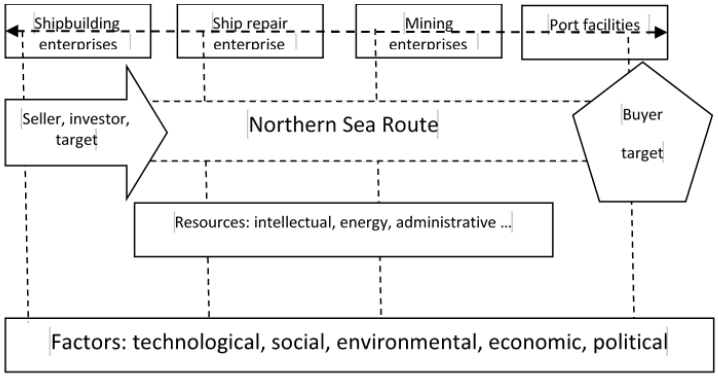

Figure 01. Conceptual model of technological development of the macroregion's ecosystem

A set of such chains creates a network, the nodes of which are key acceptors and the cells are the fields of innovative activity. The creation of such network makes it possible to diffuse innovations and transfer technologies, contributing to positive synergistic effects, which increases the sustainability of Arctic projects and leads to the development of the Arctic macroregion as a whole.

It should be noted that the ecosystem is open and its participants work both on the inside of macroregion and outside it (shipbuilding, ship repair, mining enterprises), which is reflected in the figure with dotted lines. This reflects the movement of technology both within the system and in interworking with the external environment (both sides). This ensures the acceleration of diffusion of technologies, the multiplication effect of their use and the achievement of the goals of all participants. The technologies of the Arctic macroregion are linked by social, environmental and climatic conditions, which require either the development of new technologies or the integration of those conditions into existing ones. This affects processes, taking into account climatic conditions, preserving the traditions of the small peoples of the Arctic, the ecology of the region and staffing development projects.

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7. Conclusion

We have built a conceptual model of technological development of the macroregion's ecosystem. This model is based on the technological chain, which is the source of technological development. A network is formed around the technological chain, the cells of which are represented by various acceptors. Diffusion of technologies goes from the main acceptors initiated in the technological chain to the periphery. This leads to an increase in entrepreneurial activity and technological development of the entire ecosystem. Diffusion of technology in the network requires a high-quality communication system.

The significant role of the state in the process of technological development of the macroregion's ecosystem should be noted. Government regulation should focus on providing infrastructure and creating a supportive business environment.

The significant role of the state in the process of technological development of the macroregion's ecosystem should be noted. Government regulation should focus on providing infrastructure and creating an enabling environment for business.

References

Akaev, A. A., & Turduev, M. (2010). Ob odnom podhode k matematicheskomu opisaniyu dolgosrochnoj dinamiki ekonomicheskogo razvitiya, osnovannom na uchenii o bol'shih ciklah N.D. Kondrat'eva. Prognoz i modelirovanie krizisov i mirovoj dinamiki [On one approach to the mathematical description of the long-term dynamics of economic development, based on the doctrine of large cycles of ND Kondrat'ev. Forecast and modeling of crises and world dynamics]. In *Proceedings Forecast and modeling of crises and world dynamics* (pp. 92-110). Publishing house LCI. [in Rus]

Appleyard, M., & Chesbrough, H. (2017). The dynamics of open strategy: from adoption to reversion. *Journal Long Range Planning, 50*(3), 310-321. https://doi.org/10.1016/J.LRP.2016.07.004

Audretsch, D. B., Cunningham, J. A., Kuratko, D. F., Lehmann E. E., & Menter, M. (2019). Entrepreneurial ecosystems: economic, technological, and societal impacts. *Journal Technol Transf, 44,* 313–325. https://doi.org/10.1007/s10961-018-9690-4

Balland, P.-A., Boschma, R., Crespo, J., & Rigby D. L. (2019). Smart specialization policy in the European Union: relatedness, knowledge complexity and regional diversification. *Regional Studies*, *53*(9), 1252-1268. https://doi.org/10.1080/00343404.2018.1437900

Chesbrough, H. (2003). Open Innovation. *The New Imperative for Creating and Profiting from Technology.* Harvard Business School Publishing Corporation. https://www.nmit.edu.my/wp-content/uploads/2017/10/Open-Innovation-the-New-Imperative-for-Creating-and-Profiting-from-Technology.pdf

Chesbrough, H. (2006). Open Business Models. How to Thrive in the New Innovation Landscape. *Journal of Product Innovation Management, 17*. https://www.researchgate.net/journal/1540-5885_Journal_of_Product_Innovation_Management

Dachs, B., Hud, M., Koehler, C., & Peters B. (2017). Innovation, creative destruction and structural change: firm-level evidence from European countries. *Journal Industry and Innovation, 24*(4), 346-381. https://doi.org/10.1080/13662716.2016.1261695

Deart, Yu. V., & Tsym, A. Yu. (2016). A complete model of innovation diffusion as a basis for a long-term forecast of the optimal rates of their implementation. *Journal T-Comm: Telecommunications and transport, 10*(8), 41-45.

Fraimovich, D. Y., Donichev, O. A., Grachev, S. A., & Gundorova, M. A. (2020). The role of information and digital resources in regional development. Growth poles of the global economy: emergence, changes and future perspectives. *Ser. "Lecture Notes in Networks and Systems" Plekhanov Russian University of Economics*. https://doi.org/10.1007/978-3-030-15160-7_133

Hägerstrand, T. (1967). *Innovation Diffusion as a Spatial Process*. University of Chicago Press

Karlik, A. E., & Platonov, V. V. (2017). Izuchenie organizacionno-upravlencheskih innovacij v perspektive innovacionnogo razvitiya predpriyatij [Study of organizational and managerial innovations in the perspective of innovative development of enterprises]. *Bulletin of the Faculty of Management of St. Petersburg State University of Economics, 1-1,* 487-491. [in Rus.]

Leydesdorff, L., & Zawdie, G. (2010). The triple helix perspective of innovation systems. *Journal Technology Analysis & Strategic Management*, *22*(7), 789-804. https://doi.org/10.1080/09537325.2010.511142

Melnikova, L. N. (2019). Strategiya rosta innovacionnoj aktivnosti v ramkah koncepcii «Sozdanie obshchih cennostej» [Strategy for the growth of innovation activity within the framework of the concept of "Creation of Shared Values"]. In O. N. Korableva (Ed.), *4th International Scientific Conference December 13-15, 2018, Technological perspective: new markets and points of economic growth* (pp. 568-574). Publishing House "Asterion". [in Rus.]

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). The Free Press.

Russell, M. G., Still, K., Huhtamäki, J., Yu, J. C., & Rubens, N. (2011). Transforming Innovation Ecosystems through Shared Vision and Network Orchestration. In *Proceedings of the Triple Helix IX International Conference: Silicon Valley: Global Model or Unique Anomaly? 11-14 July, 2011, Stanford, California, USA* (pp. 1-21). Stanford University, H-STAR Institute Center for Innovation and Communication.

Schwab, K. (2017). *The Fourth Industrial Revolution*. Penguin.

Shaslo, N., Petruk, G., & Korostelev, A. (2018). Determinants of integration interaction among the subjects of the entrepreneurial innovation ecosystem of macro region. *Journal Amazonia-Investiga*, *7*, 351-363.

Sielker, F., & Rauhut, D., (2018). The Rise of Macro-Regions in Europe. In E. Medeiros (Eds.), European Territorial Cooperation. The Urban Book Series. (pp. 153-170). Springer. https://doi.org/10.1007/978-3-319-74887-0_14

Stam, E. (2017). Entrepreneurial ecosystems and regional policy: A sympathetic critique. *European Planning Studies, 23*(9), 121–127.

Teece, D. A. (2014). Dynamic capabilities-based entrepreneurial theory of the multinational enterprise. *Journal of International Business* Studies, *45*(1), 8-37. https://doi.org/10.1057/JIBS.2013.54

Trifilova, A. A. (2008). Otkrytye innovacii - paradigma sovremennogo innovacionnogo menedzhmenta [Open innovation is a paradigm of modern innovation management]. *Journal Innovation, 1*(111), 74-77. [in Rus.]

Vetrova, E. N. (Ed), (2019). *Strategicheskoe razvitie innovacionno-aktivnogo predpriyatiya* [Strategic development of an innovatively active enterprise]. Publishing house of SPbSUE. [in Rus.]

Khakimova, G. R., Vetrova, E. N., Stepanova, A. V., & Kakava, L. O. (2019). Metody ocenki ekologicheskih riskov [Methods of environmental risk assessment]. In O. N. Korableva (Ed.), *4th International Scientific Conference December 13-15, 2018, Technological perspective: new markets and points of economic growth* (pp. 585-587). Publishing House "Asterion". [in Rus.]