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Algorithm for Overcoming the Monoprofile of the Arctic City: The Case of Norilsk

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Abstract. The research question of the article — identifying ways to overcome the single-industry nature of the city of Norilsk — have been concretized by solving the following tasks: to substantiate the "specificness" of Norilsk among the largest Arctic cities of Russia; to determine the role of the agglomeration effect in strengthening the support of Norilsk for the projects of Taimyr and the entire Eastern Arctic; to determine the potential of Norilsk Nickel's service structures and urban entrepreneurship for new mining and infrastructure projects in the Eastern Arctic; propose mechanisms for implementing the Norilsk Support Strategy. The methodological base of the study was formed by the concepts of technological modes, development blocking of old-industrial / mono-industrial territories and supportive settlements. Main results: Norilsk is the most specific among the largest Arctic cities of Russia according to the composite index, made up of nine key demographic, economic, socio-cultural indicators. Non-standard approaches are needed to diversify its economy. The agglomeration effect can constructively contribute to Norilsk's transformation from a single-industry city into a base city for the development of the Eastern Arctic. The most important areas of structural transformation of Norilsk's economy include strengthening the practice-orientation and geographical expansion of consumers of services of the local scientific and educational complex; establishment of an entrepreneurial layer in new industries and types of production activities; and entry of the city's entrepreneurship together with the plant's service structures into the market of projects and settlements in the Eastern Arctic. The main mechanisms for the implementation of the Norilsk Strategy are: "mirror" actions in the eastern Arctic of the city and the Norilsk Nickel combine; transformation of Norilsk into a center for the provision of security services for the territories of the eastern Arctic; a center of formation of the Arctic cruise tourism from Dudinka to Anadyr; a center for accumulating best practices of renovation of the Arctic housing and communal services for their replication in the cities and towns of the Eastern Arctic. Recognition of Norilsk's success in becoming a base city in the Eastern Arctic will be an increase in its administrative status: transformation into a city of federal significance.

Keywords: *monoprofile city, core city, transformation, Arctic agglomeration effect, composite index of specificity, structural shifts in the urban economy, Norilsk, the center of development of the Eastern Arctic*

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Introduction

For almost a century, the dynamics of the economic development of the city of Norilsk, its attractiveness to migrants and the tone of its social development have been depended on the city-forming enterprise Norilsk Nickel. The new realities of large-scale development of Taimyr, the rise of the Asian Arctic, where the main new projects of the Arctic zone of the Russian Federation will be launched in the coming decades, put forward the strategic task of radical diversification of the city's economy, expansion and "extension" of its basic functions for the neighboring eastern Arctic territories. This should become a new driver for the development of Norilsk. The relevance of precisely this large-scale task is dictated by federal, Arctic (zonal), regional and local arguments.

Due to Western sanctions, Russia is turning to the Asia-Pacific countries. The country urgently needs cities that can become a state "anchor" for such a turn in the Arctic, along the NSR route — like container warehouses, logistics bases, reliable transit supply bases. The city of Norilsk, the port of Dudinka, and the Alykel airport are capable of fulfilling these tasks with a clear state policy in this matter and careful depressurization of their former corporate mono-profile.

In the context of the geopolitical rise in the significance of the Russian Arctic, it is important for the country to have an independent and economically strong outpost city not in the European, but in the eastern, Asian, part: the Western sanctions increase the need for internal consolidation of the few small elements of the settlement of the eastern Arctic. Norilsk could potentially act as such a "collector" of qualified personnel, a technological, production service center for the neighboring regions of the Republic of Sakha (Yakutia) and the Chukotka Autonomous Okrug [1].

The Taimyr Peninsula is already becoming a platform for the implementation of new projects by a dozen Russian resource corporations. It would be wasteful to miss the opportunity to provide their basic "equipment" to the nearest and largest city in the eastern Arctic. The country simply does not have another such large city in the eastern Arctic as Norilsk, or such a large port for supplying Asian Arctic projects as Dudinka. Dudinka could take over from Murmansk the functions of delivering social goods for the eastern Arctic according to the long-existing "Yenisei–NSR" scheme (this can be seen as a revival of the idea and practice of "Kara expeditions" of the early 20th century).

The focus on mono-industry in the context of deep technological changes in the city-forming enterprise itself seems to be used up for the city and threatens a further significant reduction in the population. Statistics confirm that in recent years there has been a reduction in the number of workers in manufacturing (that is, metallurgical) industries — the main ones for the company.

[1] Strategiya sotsial'no-ekonomicheskogo razvitiya munitsipal'nogo obrazovaniya gorod Noril'sk do 2035 goda kak opornogo goroda Arktiki (vostochnoy Arktiki). Utverzhdena resheniem Noril'skogo gorodskogo Soveta deputatov ot 20 iyunya 2023 goda № 8/6–193 [Strategy for the socio-economic development of the municipality of Norilsk until 2035 as a supporting city of the Arctic (Eastern Arctic). Approved by decision of the Norilsk City Council of Deputies dated June 20, 2023 No. 8/6–193]. URL: https://norilsk.ru/files/50741/83786/strategiya_2035.pdf (accessed 08 August 2023).

The introduction of artificial intelligence technologies at the Norilsk plant (the "Technical breakthrough 2.0" program, implemented in the "Industry 4.0" ideology, the creation of digital twins of real production processes, "Sulfur program 2.0", etc.) means, in the long term, a transition to unmanned, fully automated production. For example, by 2025, ore mining at the Glubokaya mine of the Skalistyy mine at a depth of 2–2.5 km will already be carried out in the most autonomous mode.

For the city, this means the need to look for new opportunities for economic self-realization. It is impossible to attract and retain talents without a new challenge project. Qualified personnel and talents clearly determine the type of dynamics of the future development of Norilsk [2].

This new urban development project for Norilsk should be aimed at turning it (together with Dudinka and Alykel) into a supporting city for the development of the eastern Arctic and transit routes to the countries of the Asia-Pacific region. In Soviet times, the city already partially fulfilled these functions: it was a natural laboratory for developing new methods of pile construction on permafrost, growing crops in the Arctic, testing equipment in extreme natural conditions, etc. [3] It is a question of returning to these tasks in an intensified mode, taking into account the shift of investors' attention to the Eastern Arctic and the new geopolitical situation (primarily the closing of traditional European markets for the natural resources of the Russian Arctic).

The object of the study was the single-industry city of Norilsk as the most specific one in the Russian and world Arctic, the largest center of Russia in the eastern Arctic. The subject of the study was the key, closely interconnected factors of overcoming mono-industry — the transformation of Norilsk into a base for the development of the Eastern Arctic and raising its status to a city of federal significance.

The purpose of the study was to determine the algorithm (specific actions) for overcoming the modern single-industry nature of Norilsk (through a new support and a new status). It determined the necessity of solving four research tasks:

- to justify the "specialness" of Norilsk among other major Arctic cities of Russia as a prerequisite for the subsequent proposal of extraordinary actions to dynamize the development of the city;
- to characterize the specifics of the agglomeration effect in the Arctic conditions and determine its specific role in strengthening the support of Norilsk in performing basic functions for new projects in neighboring Taimyr and the entire eastern Arctic;
- to determine the potential of the service structures of Norilsk Nickel and city universities as factors in the "supply" of production services for new mining and infrastructure projects in the eastern Arctic;

[2] Ibid.
[3] Pilyasov A.N. Noril'sk mozhet stat' stolitsey vsey aziatskoy Arktiki [Norilsk can become the capital of the entire Asian Arctic]. Interview. Newspaper "Oxygen.Life". February 24, 2021. URL: https://kislorod.life/opinions/norilsk_mozhet_stat_stolitsey_vsey_aziatskoy_arktiki/ (accessed 01 July 2023).

- to propose the main mechanisms for implementing the Norilsk as the Basic City Strategy through: a) radical expansion of the basicity area from Taimyr to the eastern Arctic; b) unified strategy for the actions of the city and the plant in the eastern Arctic; c) obtaining the status of a city of federal significance.

The author's background for this study includes several previously published works and interviews [4] on the problems of modern development of single-industry towns, including Norilsk [1–2]. The novelty of this work lies in the consideration of the particular problem of diversifying the economy of Norilsk in the global context of the formation of new geopolitical and geo-economic alliances in Asia and the expected changes in the Asian Arctic associated with the implementation of a significant number of new mining projects there. Another new aspect that deepens previous ideas is associated with the development of a specific algorithm of actions (events) for the transformation of Norilsk from a single-industry city to a base city, compatible with the existing Russian management practices and traditions. For the first time, a specificity index was developed, which made it possible to compare the largest cities in the Russian Arctic according to this criterion.

The information basis of the work was, firstly, the materials from municipal regulatory legal acts, primarily key strategic planning documents — the Plan for the modernization of the single-industry city of Norilsk (approved by Resolution of the Administration of the city of Norilsk, Krasnoyarsk Krai dated January 10, 2014 N 01 (as amended by the Resolution of the Administration of the city of Norilsk, Krasnoyarsk Krai dated November 7, 2017 N 501); Strategy for the socio-economic development of the municipal formation of the city of Norilsk until 2030 (approved by the decision of the Norilsk City Council of Deputies dated December 18, 2018 No. 10/5-229); 25 current municipal programs of the city of Norilsk ; secondly, municipal statistics data for the largest Arctic cities of Russia; thirdly, personal interviews with experts and leaders of the city of Norilsk, which the author has conducted over the past 30 years, first as Head of the Arctic Department of the State Committee for the North of Russia, then as Director of the Centre of the Economy of the North and Arctic, Council for the Study of Productive Forces, in recent years — as General Director of the ANO Institute of Regional Consulting.

Methodology and research methods

The theoretical and methodological basis for developing ways to diversify the economy of the single-industry city of Norilsk are three research trends that have been actively developing in recent decades in world social science. The first trend is work on technological structures in line with the integrated paradigm of Kondratiev–Perez–Glazyev [3–5], which give an idea of the general philosophy of the economy of the new technological era of the fifth and sixth Kondratiev (development of robotics and sensors, nanotechnology, artificial intelligence systems, Internet of things, virtual or augmented reality of digital twins, unmanned vehicles, additive technologies,

[4] Pilyasov A.N. Noril'sk mozhet stat' stolitsey vsey aziatskoy Arktiki [Norilsk can become the capital of the entire Asian Arctic]. Interview. Newspaper "Oxygen.Life". February 24, 2021. URL: https://kislorod.life/opinions/norilsk_mozhet_stat_stolitsey_vsey_aziatskoy_arktiki/ (accessed 01 July 2023).

wireless communication technologies, global information networks, integrated high-speed transport systems, etc.). On the one hand, these technological trends reduce the social, value and partly economic significance of the city-forming enterprise; on the other hand, they give the single-industry city of Norilsk a chance to effectively perform the functions of a "support" in Taimyr and in the eastern Arctic as a whole — as a "capital" city, a center of interregional influence.

The modern strength of the city is ensured by innovation, technology, and the quality of human capital, for which Norilsk has a higher potential than neighboring Arctic cities. Previously, it was accumulated in the interests of the city-forming enterprise, and now the task is to deploy it for the successful implementation of the city's basic functions.

The second research trend is associated with identifying the main barriers to the economic diversification of a single-industry city in the form of an idea of three blocks to new development: cognitive, functional, political lock-ins [6–8]. Norilsk is a textbook case of how the decades-old "track" shapes the cognitive (inertial ideas about development opportunities only within the framework of an already established economic specialization), functional (inviolability of the contracting of the city-forming corporate structure with the main economic partners) and political ("merger" of the management of the city-forming enterprises and of a single-industry city) lock-ins to development [2]. Norilsk Nickel still accounts for about 95% of industrial production and 80% of the city's gross municipal product as it was 30, 50 years ago. As the period of development uninterrupted by disasters increases, the shortage of ideas about alternatives to the once chosen path of development inevitably increases, and doubts about the advisability of an alternative search if the current situation is favorable and sufficiently stable grow [2].

The third research trend is related to the concept of support settlements. The concept reflects the extreme unevenness of spatial development, which is usually characteristic in the first phases of the deployment of a new technological structure (in our case, associated with artificial intelligence). Similarly, support settlements were spoken about at the dawn of the formation of an industrial structure in the Far North of the USSR a hundred years ago. Subsequently, when a new technological structure conquers the main economic spaces of the country and spatial development becomes more uniform, the concept of "support" dies out [5].

For the first time (or in one of the first federal regulatory legal documents) the concept of support [6] was used in the Spatial development strategy of the Russian Federation for the period

[5] Strategiya sotsial'no-ekonomicheskogo razvitiya munitsipal'nogo obrazovaniya gorod Noril'sk do 2035 goda kak opornogo goroda Arktiki (vostochnoy Arktiki). Utverzhdena resheniem Noril'skogo gorodskogo Soveta deputatov ot 20 iyunya 2023 goda № 8/6–193 [Strategy for the socio-economic development of the municipal formation of Norilsk until 2035 as a supporting city of the Arctic (Eastern Arctic). Approved by decision of the Norilsk City Council of Deputies dated June 20, 2023 No. 8/6–193]. URL: https://norilsk.ru/files/50741/83786/strategiya_2035.pdf (accessed 08 August 2023).

[6] "Support settlement" is a settlement on the basis of which accelerated development of social, transport and engineering infrastructure is provided to ensure the implementation of guarantees in the field of education, access to medical care, cultural services and the fulfilment of other needs of the population of the territories of one or more municipalities. It is envisaged that these anchor settlements will ensure "advanced development of territories with a

until 2025 (Order of the Government of the Russian Federation dated February 13, 2019 N 207-r; as amended by the orders of the Government of the Russian Federation dated 08/31/2019 N 1945-r, dated 03/23/2021 N 719-r, dated 12/16/2021 N 3633-r, dated 06/25/2022 N 1704-r, dated 09/30/2022 N 2877-r). In the last year, a special study on the supporting cities and towns of the Arctic was conducted [9]. In this study, Norilsk is defined as simultaneously possessing five support functions: a center for supporting the mining industry, a transport and logistics support settlement, a center for innovation and information support, a center for socio-cultural support of the population and an internal security support settlement.

Our difference in understanding the Norilsk support from the authors of this work consists of two aspects. Firstly, we do not consider the Norilsk support per se, but as a favorable condition, as a basis for further diversification of its economy through a set of new "core" types of economic activities that can be provided to surrounding territories (settlements and municipal areas) and detailed specialization cities in already existing support functions. Secondly, we put forward the task of significant geographical expansion of the Norilsk support base: the provision of production, transport and social services not only for the surrounding territory, but for the entire Taimyr region as a territory of pioneer development, to the eastern Arctic (Arctic uluses of Yakutia and the Chukotka Autonomous Okrug) — we see the process of gradual development of the local support of Norilsk into a zonal one for the entire eastern Arctic.

Main results

1. The most special city of the Russian Arctic

Norilsk is undoubtedly the most special city in the Russian, and perhaps, the global Arctic. The exaggerated specificity is a consequence of the unique wealth of the local mineral resource base, which made it possible to mine ore from the surrounding Norilsk deposits for almost a century, preserving the location of the city's core; extreme climatic conditions (here one can recall the famous Norilsk "black blizzards"), which for decades were aggravated by regular emissions of sulfur from mining and metallurgical enterprises; enclave geographical location (extreme transport isolation from the main network of roads and railways of the country). In the 20th century, a special industrial region was created in Taimyr — an Arctic economic island with a monopoly departmental structure of the Norilsk Nickel plant (now, after corporatization, it is the oldest Arctic corporation in Russia) and the unique accumulated competencies of sedentary life in these uncomfortable conditions of three generations of workers.

Let us evaluate the degree of specificity of Norilsk in comparison with other largest cities in the Russian Arctic. To obtain reliable results, it is necessary to "compare the comparable", that is, to take the largest from the initial sample of Arctic cities, with a population of more than one hundred thousand people (as many urbanists believe, one hundred thousand inhabitants for an Arctic

low level of socio-economic development, which have their own potential for economic growth, as well as territories with low population density and projected increase in economic potential".

and northern city is a kind of threshold that differentiates settlements into centers of local and interregional (zonal) influence: Norilsk, Murmansk, Arkhangelsk, Severodvinsk, Novyy Urengoy, Noyabrsk. In this list, Murmansk and Arkhangelsk are the administrative capitals of the regions, four cities are single-industry (Severodvinsk is single-industry in military-industrial complex mechanical engineering, Norilsk — in mining and metallurgical production, Novyy Urengoy and Noyabrsk — in hydrocarbon production).

To assess the degree of specificity, we use the method of creating a composite latent indicator, which is often used by researchers when comparing countries, regions and cities of the world (one of the most famous examples is Richard Florida's composite index of creativity of countries) [10–11]. In accordance with this method, all indicators are converted into dimensionless indices (normalized) using the formula: Ri= (Xi-Xmin)/(Xmax-Xmin) or Ri= 1-((Xi-Xmin)/(Xmax-Xmin)), so that all cities line up from 0 (worst value) to 1 (best value).

Partial indices for the blocks "demography" (D), "economy" (E), "social sphere" (S) are calculated as the arithmetic average of their constituent indicators. The composite specificity index (CSI) is calculated as the arithmetic mean of the partial indicators.

Of the variety of indicators that can characterize the specificity of an Arctic city, it was decided to take the most accessible to the researcher, obvious in terms of the features they characterize and easy to use (that is, not aggregate). These turned out to be demographic, economic and social ones.

The first ones characterize the peculiarities of the local community of the city, first of all, the degree of its "productivity". It is known that cities in the Arctic emerged as administrative centers of state presence, or as resource, mining (production and transport) settlements. From the perspective of differences from "mainland" ones, the resource cities of the Arctic are special first of all.

The second ones reflect the economic profile of the city, in our case, answering the crucial question of whether the city is mono-profile or multifunctional (in the Arctic this means metropolitan). A single-industry city is also economically more specific due to the special problems that arise in its relationship with the city-forming enterprise.

The third ones characterize the state of the social sphere, and in a broad interpretation — the socio-psychological, socio-cultural state of the city. In the specific realities of an Arctic city, this means assessing the degree of "islandness" of the entire urban social system. The more insular it is, the more specific it should be recognized. Thus, our approach to assessing the specificity of an Arctic city implicitly means determining the degree of its remoteness from the standards of large cities in the temperate zone, which, on the contrary, are multidisciplinary, transport-equipped, organizationally and culturally diverse.

The demographic index was formed as the arithmetic mean of normalized indicators of population density, gender structure (ratio of men and women) and the share of the working-age population in the total population of the city (Table 1). The first characterizes the degree of com-

pactness or, conversely, dispersion of urban spaces. Our expectations are based on the fact that the Arctic city is an administrative center or, as a mono-resource city, has a feature versus the "mainland" city in the relatively easy capture of surrounding undeveloped spaces. It should therefore be generally less "dense" than a typical large temperate zone city. This is often empirically confirmed by the fact that Arctic cities sometimes have separate areas that are tens of kilometers away from the historical center (for example, Norilsk or Noyabrsk). In this regard, an Arctic city is all the more specific, the less densely populated it is internally.

The classic industrial and fishing Arctic demanded male labor in the main "life-sustaining" types of economic activity. Therefore, our expectations to see traces of these traditions in the gender structure of the largest Arctic cities are justified. The further an Arctic city is from its mainland "twin", the more masculine it should be. Therefore, the gender structure, the ratio of men and women in the local human population, is an important characteristic of preserved (or, conversely, lost) Arctic specificity.

The share of the working-age population similarly characterizes the extent to which city residents are connected to work: after all, it is well known that the natural extremes of the Arctic shape the life plans of many people to temporarily reside here during the work cycle (and upon its completion, to leave the North). Therefore, the more pragmatic the population structure is in terms of unambiguously linking urban residence with work, the more (other things being equal) it can be recognized as being Arctic-specific, that is, removed from mainland city standards (when there are many pensioners, disabled people, people unable to work due to more comfortable living conditions).

In terms of all demographic indicators, Norilsk has clear differences in comparison with other major Arctic cities of Russia (which, in turn, differ from major mainland cities): it has minimal urban population density; clear and rare for the Russian Arctic male dominance in the urban population; maximum share of the working-age population. Therefore, we can say that Norilsk has specificity squared.

The economic index was formed as the arithmetic mean of the normalized indicators of per capita investment, per capita industrial production and the number of enterprises per 1000 people (Table 1). The first characterizes the tone of economic development, activity in creating new and updating old fixed assets: all of them — corporate and budgetary investments in the city. There is nothing particularly Arctic in this phenomenon itself: both capital cities (for example, Moscow) and single-industry cities in the temperate zone can have either exceptionally high or low rates of per capita investment.

However, when comparing cities within the Arctic zone, new knowledge arises: which of them has that high economic tone, for the sake of which, in fact, Arctic cities exist in the Arctic zone: in conditions of high production and living costs, their justification is largely ensured by the tone the entire dynamics of economic development (otherwise why are they needed?). Therefore, dynamism can be considered that essential specificity of an Arctic city, which should set it apart

from the more “calm” cities of the temperate zone (however, it should be said that after a phase of dynamic development, Arctic cities can also experience periods of such depression and failure, up to closure, which are difficult to imagine for cities of similar size in the temperate zone).

The per capita volume of industrial production, which was obtained as a result of summing up Economic activity indicators — the volume of shipped goods of own production, work and services performed in-house for the extraction of minerals; manufacturing industries; provision of electrical energy, gas and steam, air conditioning; water supply, sanitation, organization of waste collection and disposal, pollution elimination activities — characterizes the degree of monoindustry of the city. In itself, it is not a purely Arctic specificity, but taken within a sample of Arctic cities, it certainly characterizes the peculiarity of the city as a purely production, single-industry (or, conversely, more administrative and service-oriented).

The latter indicator of the number of enterprises per 1000 people is an indicator of the organizational diversity of the city’s economic structure. Thus, it is not explicitly Arctic specific, but if we see the Arctic city as more “thin” in terms of institutional environment than a “mainland” city, then it turns out that the more uniform the organizational environment, the more the city is removed from the mainland standard with its typically diverse organizational, economic, and cultural environment (single-industry cities on the mainland are the exception rather than the rule in their general pool; for the Arctic, on the contrary, the presence of single-industry, mining cities is absolutely typical). Within the sample of Arctic cities, this indicator clearly stratifies them into two groups — single-industry ones, in which there is no organizational diversity and the indicator is minimal, and more diversified, in which the indicator is maximum.

The question may arise: why are the common indicators of the unemployment rate, per capita income, and industry structure not used in the assessment? All these indicators can be the result of different forces and not necessarily derived from Arctic specifics. We tried to select for evaluation only those that, in our opinion, pursue the idea of differences between an Arctic city and its mainland counterpart, assessing it in terms of its distance from the universal standard of a temperate zone city.

We believed that by choosing the criterion of remoteness from the mainland analogue, we would be able to find the most remote and less remote cities within the sample of the largest Arctic cities and to choose the most specific one (the most Arctic).

Norilsk is extreme in each of selected economic indicators: it has the highest indicators of per capita investment, industrial production volume, but minimal indicators of organizational diversity — the number of enterprises and organizations per 1000 people. That is, it appears as a strongly single-industry city compared to other Arctic cities; it has a single-industry specificity squared even in comparison with the gas capital of Russia — Novyy Urengoy.

The social index was formed as the arithmetic average of the number of doctors per 10.000 people, the number of hospital beds per 10.000 people and the city’s inclusion in areas with limited delivery times for goods (yes/no).

Let us explain the "strange" set of indicators for assessing the urban social system. Many years of experience in working with the public sector of Arctic cities has led to the conclusion that urban healthcare is the most specific area in which the differences between an Arctic city and a mainland city are greatest. In the Arctic city, the polyclinic model of medicine is usually reduced, on the other hand, the hospital model of medicine is more developed. There is always an acute shortage of qualified personnel, so the supply of labor resources is shifted to nurses, and there are fewer doctors (especially with a narrow specialization) compared to similar conditions on the mainland. Perhaps such Arctic specificity also exists in the education system, but it is much more difficult to identify it with superficial statistical indicators; it is recorded at a deeper level.

Therefore, from the viewpoint of diagnosing differences and Arctic characteristics, urban medicine is "more grateful" for the researcher than education or an even more unified culture. Hence our attention to the indicators of the provision of doctors (which are traditionally scarce in the Arctic) and beds (which characterize the dominant hospital rather than outpatient model of medical care here — small air ambulances take patients from remote areas directly to hospitals, and not to polyclinics).

The inclusion of an indicator of the city's transport accessibility in the block of social indicators —whether it belongs to areas with limited delivery times or not — seems completely unexpected. However, transport isolation is so pervasive in all aspects of the city's social and cultural life that the same resulting values of social indicators of Arctic cities on a year-round network and in an area with limited transport accessibility may in fact indicate completely different quality, forms, costs provision and delivery of social services in both cases.

Norilsk, even in this space of social indicators, turned out to be the most specific among the already specific cities of the Arctic (Table 1): it has the smallest number of doctors, and it is the only one of all the large cities of the Arctic that does not have year-round land connection with the "mainland".

Table 1

Comparison of the largest Arctic cities in Russia, as of January 1, 2022 [7]

	Norilsk	Murmansk	Arkhangelsk	Severodvinsk	Novyy Urengoy	Noyabrsk
Total population	*184.1*	*279.1*	*342.2*	*179.7*	*118.7*	*109.5*
D1. Population density, people/km^2	41.0	1 659.5	1 185.7	151.4	1 046.4	90.2
D2. Share of women per 1000 men	984	1 169	1 242	1 134	1 015	1 062

[7] Sources for calculation: Regiony Rossii. Osnovnye sotsial'no-ekonomicheskie pokazateli gorodov. 2022. Noril'sk-2022. Slagaemye byudzheta [Regions of Russia. Basic socio-economic indicators of cities. 2022. Norilsk-2022. Components of the budget]. URL: https://xn--h1aecgfmj1g.xn--p1ai/files/40634/179803/1_osn_svedeniy.pdf (accessed 03 July 2023); Itogi sotsial'no-ekonomicheskogo razvitiya munitsipal'nogo obrazovaniya gorod Noril'sk za 2022 god [Results of the socio-economic development of the municipality of Norilsk for 2022]. URL: https://norilsk.ru/files/22661/33155/itogi_2022.pdf (accessed 03 July 2023).

D3. Share of working-age population, %	68.5	59.9	60.4	57.2	66.2	64.1
Private index of D-specificity	*1*	*0.174*	*0.192*	*0.450*	*0.685*	*0.760*
E1. Per capita investment in fixed capital (in actual prices), thous. rub.	832.2	328.2	90.0	59.0	457.5	118.7
E2. Per capita volume of industrial production, thous. rub.	4912	707.9	222.2	56.4	865.0	346.3
E3. Number of enterprises and organizations per 1000 people	10.9	31.2	27.3	13.2	21.1	11.3
Private index of E-specificity	*1*	*0.161*	*0.089*	*0.296*	*0.393*	*0.372*
C1. Number of doctors per 10.000 people	40.8	73.4	86.1	64.2	57.7	68.5
C2. Number of beds in 24-hour hospitals per 10.000 people	65.3	122.3	96.7	82.5	63.3	68.1
C3. Area with limited delivery times for cargo: yes / no	1	0	0	0	0	0
Private index of C-specificity	*0.989*	*0.093*	*0.145*	*0.386*	*0.542*	*0.436*
Composite specificity index (CSI)	0.996	0.143	0.142	0.377	0.540	0.523

It is not surprising that according to the composite specificity index (CSI), Norilsk turned out to be the most special among the largest cities in the Arctic, leaving the second city in this ranking, Novyy Urengoy, far behind. The entire city, as an economic island with a monopoly corporate structure, can be considered a “specific asset” [12]. Hence, it inevitably follows that the solutions to diversify its economy and depressurize its mono-industry should be sought for piecemeal, individual, special — non-routine ones.

2. Arctic agglomeration effect and how it can be used to overcome the single-industry nature of Norilsk

For Norilsk, a conceptual understanding of the Arctic features of the manifestation of the agglomeration effect is of practical importance, because it determines to what extent and how this effect can be used for transformation from a single-industry city to a supporting one, the basis for the development of Taimyr and the entire eastern Arctic.

Traditionally, the agglomeration effect is associated with the activities of cities, especially large ones [8], in which the environment of high population density and economic entities creates favorable preconditions for the maximum emancipation of its power. The first (classical) work on the agglomeration effect appeared in 1961 [13], but only since the 1990s there has been a revolution in research interest in the agglomeration effect and related issues of geographic concentration of economic activity [14–17], which revealed the sources of increasing returns for the economy (when a single increase in factors of production in an environment of dense communication and economic interaction of economic actors provides the snowball effect — a multiple greater increase in the results of output volumes, production, gross product).

However, numerous "classical" studies of agglomeration and agglomeration effect neglect geography and history: they do not take into account the factors of changing latitudinal zonality and evolution of technological structures in cities — agglomeration centers. It is reasonable to understand urban agglomeration not as a static state, but as a spatio-temporal process that is associated with the action of internal and external forces.

What does this mean for large Arctic cities — agglomeration centers? They should be considered, certainly recognizing their significant differences from the cities of the temperate zone on the one hand, on the other hand, in the context of their transition from the fourth to the fifth technological order, based on information technology, artificial intelligence and the Internet of things.

What are the Arctic specifics of the agglomeration effect?

- The ultra-low overall economic and settlement density of the Arctic zone of the Russian Federation determines the special role and significance of a few high-density enclaves, densely populated land plots housing large cities — new centers of intellectual wealth in the Arctic (along with long-known mining centers of resource wealth). It is quite possible that the comparative importance of such large urban centers with a population of one hundred thousand for the Arctic is higher than cities with a population of one million for their temperate zone. In the case of the Arctic, not only constant, year-round, but even temporary high density is important, for example, in a single-industry city during periods of intensive pioneering development of a "feeding" field, or during major events of an international, national or interregional/zonal nature.
- The inseparable unity of economic activity and transport infrastructure in the Arctic (especially strong at the stage of pioneer economic development) means for an urban agglomeration the presence of two fundamentally different situations: a) agglomeration on a year-round land network; b) agglomeration located in areas with limited delivery times. In the first one, agglomeration effects unfold close to the diagram of the

[8] The canonical definition is that the agglomeration effect is associated with the existence of cities of over 100 thousand people, which have satellite cities within an hour's accessibility (usually up to one hundred kilometers).

Christaller hierarchy of service centers; in the second — to the scheme of supporting base cities, first described by the famous Soviet northern expert S.V. Slavin.

- Strong corporate influence on large Arctic cities: resource corporations — on mining monotowns of the Arctic; state corporations Rosatom, the Ministry of Defense, the Ministry of Emergency Situations — on large administrative centers and regional capitals. In the Arctic conditions, not only classical large administrative or service centers can produce an agglomeration effect, but also resource centers — in this case it has a "corporate" genesis.

Thus, the Arctic agglomeration effect has a year-round and temporary, seasonal or event-based manifestation; in its strength of manifestation, it acutely depends on the specific forms of coupling of economic and transport and logistics functions (all functions are connected in one city, the functions of production activities and sea/river/air transport support are carried out in neighboring cities; whether the center of the urban agglomeration itself is located on a year-round ground network or in areas with limited delivery times); on the strength of the structure-forming corporate framework and the form of partnership of the city authorities with it.

What is the specificity of the agglomeration effect at the stage of transition from the third or fourth Kondratiev to the fifth or sixth? In the industrial era, the pioneering development of the Arctic and the North took place areally, spatially, with the simultaneous formation of large mineral resource centers, regional energy and transport infrastructure. The unity of technologically linked mining and infrastructure production is called territorial-production (district inter-industry) complexes. The regional effect obtained from the "fresh" large West Siberian oil and gas fields, when their large-scale development involved the simultaneous deployment of production, energy and transport facilities linked into systemic unity in a large areal (district) complex, ensured the profitability of the entire West Siberian oil and gas project. As for the agglomeration, large-city effect, it was in the third or fourth technological order in the North and the Arctic, in the shadow of the regional one.

But everything changed during the transition to the fifth Kondratiev, when large cities, including in the Arctic, began to be understood as "innovation machines" [18], that is, places where talent is concentrated, new knowledge is developed, experience and best practices are exchanged through ultra-dense communication [9].

Unlike the regional one, the agglomeration effect operates at an "arm's length" distance, that is, 100, up to 150 km (the regional one can involve economic entities at a distance of up to several hundred km into its orbit). It is not surprising that, simultaneously with the agglomeration effect, the topic of economic clusters was developed in research as a network of collaborating companies localized in the "near-circuit" (city, single labor market, district), linked to the local sci-

[9] Therefore, the strength of the agglomeration effect can be measured not only by the volume of the consumer market of the central city and its nearby satellites, but also by the products of innovative activity, for example, the number of patents per thousand inhabitants.

entific and educational complex and the structural divisions of the local government that supports them. It was at the fifth stage of Kondratiev that the “close” and seemingly complementary and reinforcing each other agglomeration and cluster effects moved into the main research agenda of spatial effects, and the regional effect was pushed into the “shadow” of scientific discussion in the economy of the Russian and Arctic regions. This is also due to the fact that the innovative activity, on which the technologies of the fifth Kondratiev are based, is over-concentrated in space by its nature (compared to the industrial activity of the third and fourth Kondratiev).

The author received confirmation that the agglomeration effect in the Arctic is not a speculative construct, but a reality, when leading the development of the strategy of three neighboring Yamal cities — Noyabrsk as the center of an urban agglomeration with a population of one hundred thousand, Muravlenko as a satellite city of Noyabrsk, and Gubkinskiy as a city too geographically remote from Noyabrsk to fall under its agglomeration effect. The result of the comparison of the “satellite” Muravlenko and the “non-satellite” Gubkinskiy was the statement of major differences in the economic behavior of the city authorities (you have a “big brother” or you are the “real owner of your small ranch”), the structure of the types of economic activities of small businesses in both cities and different quality and workload of the cultural sphere, in particular, local history museums [19].

As previously noted, Arctic urban agglomerations are internally heterogeneous and can be divided into several types:

- a) Christaller (overland), when a city-administrative or resource center provides a range of services for nearby smaller urban settlements, with which it is connected by intensive production, transport, logistics and socio-cultural ties. In this case, the city-agglomeration center concentrates the functions of an economic and multimodal (airport, railway station, river port, bus station) center. Such an agglomeration center of the quasichristaller “continental” type is, for example, Noyabrsk.
- b) The overland situation is also much more specific, when either the agglomeration center, or its satellites, or all of them together are located in areas without a year-round land transport network: b1 — Novyy Urengoy as a city-centre is itself located on a year-round transport network, but the numerous settlements of shift workers around it are located in areas with limited delivery time. There is an “air agglomeration”: the Novyy Urengoy airport serves as a base for all mono-resource satellite villages around; b2 — Norilsk and its satellite cities are all located outside the year-round ground transport network, but inside the Norilsk industrial area they are united by an “island” road network. The presence of large cities such as Yakutsk, Norilsk, located outside the year-round transport network, but at the same time serving as the center of an agglomeration of cities “off-road”, is the strongest Russian specificity [20]. Indeed, all over the world, including in the Arctic countries, the existence of the agglomeration effect is strictly linked to the presence of a permanent transport network between the center of

the agglomeration and satellite cities. However, in the Russian Arctic, the agglomeration effect works both in the case when the center itself is on a year-round network, but its satellites are not (Novyy Urengoy), and when both the center and satellite cities are not on a year-round surface national road network, but are connected by an "island" highway (Norilsk–Dudinka–Alykel).

- c) The maritime Arctic factor introduces the most important feature in the form of the abolition of the Christaller hierarchy — all Arctic centers of urban agglomerations located at sea, like global cities, are included in the pan-Arctic network, and size does not matter here and does not determine their place in the hierarchy — they are like sea outposts countries, of equal value. These are Murmansk and Arkhangelsk, which are located on the sea coast, have seaports and at the same time serve as city centers for the agglomeration network (Murmansk — Kola, Severomorsk, Gadzhievo, Murmashi; Arkhangelsk — Severodvinsk, Novodvinsk, etc.).

In this classification of Arctic agglomerations, Norilsk occupies a very special place, because it combines features of all types at the same time: it has features of a "land" hierarchical agglomeration, as well as features of a sea agglomeration (due to its inclusion in the agglomeration network of a river/sea port Dudinka); features of a large administrative center of a vast territory: Norilsk — the territory of the Norilsk industrial district, Dudinka — the Taimyr municipal district; features of an "air agglomeration" (due to the patronage of Snezhnogorsk, which is part of the city, but is connected with it only by air); common features of "roadless" agglomeration centers located in areas with limited delivery time.

Instead of the usual multifunctional city-center of an agglomeration, as in areas with year-round land communications and dense settlement of the temperate zone, in the case of the Norilsk industrial district, a "distributed" agglomeration of a polycentric structure arises from one production (Norilsk) and two transport and logistics centers (Dudinka, Alykel). Norilsk is the main production center, Dudinka is the main sea/river port gate of Norilsk to the Yenisei and the Northern Sea Route, the village of Alykel is the air gate of Norilsk.

Why does this separation occur? The first reason is the location of the mining center — a single-industry city in an area with limited delivery time, which means impossibility to rely on a network of land roads and dependence of such a single-industry city on water and/or air transport. As a comparison of Norilsk, an isolated island, with other largest cities in the Arctic, which are located on the all-Russian network of roads and railways, shows, it is in the first case that there is a clear spatial separation of production and transport functions across several cities (in the second case, the functions are consolidated in one city).

But why couldn't an airport be built in Norilsk and seasonal water delivery of goods be organized? This is where the geographical factor comes into play. As a rule, Arctic mining operations created in the industrial model were based in single-industry towns in areas with mountainous terrain (which is absolutely natural), near natural resource deposits. Water ports associated with

large rivers or sea deltas will require a different landscape and relief. Likewise, airports require vast valleys for modern large transport and passenger aircraft to take off and land. Different requirements for the relief of mining production and transport hubs in the conditions of tightly integrated "industrial and transport" development of the North inevitably cause spatial dispersion of the mining center in the mountains, the airport on the plain and the sea/river port in the valley or on the coast.

Therefore, in areas with limited terms of cargo delivery, single-industry mining cities inevitably had to exist in the vicinity of river port cities and towns (villages) with airports (for small aviation, which serves small single-industry villages, this pattern does not apply — the airport can be located in the very village).

Our fellow researchers of the supporting settlements of the Russian Arctic note that the Arctic zone is often characterized by the phenomenon of "spreading" the most important functions of the city (primarily production, transport and logistics) over several neighboring settlements [9]. In this case, there is a rejection of the Christaller hierarchical lattice of multifunctional central places and a transition to a local network of centers specialized in a particular function. However, this is true only in the specific circumstances of mining development in the era of the third Kondratiev.

For the "plain" oil and gas economic development, which followed the mining industry in the next wave in the 1960–1970s, already in the fourth Kondratiev, these patterns do not work (the landscapes of mining production and transport logistics coincide here — one city is able to perform all functions at once): significant volumes of export demanded the creation of an initially year-round transport network — all large single-industry towns created in that period, as a rule, had a year-round operating supporting railway and highway.

Only Norilsk can be called a canonical Arctic agglomeration out of all the listed ones (Table 2):

- the city is located in an area with limited delivery time,
- resource (production) profile,
- production and transport functions are dispersed across three cities: Norilsk, Dudinka, Alykel (Fig. 1).

Table 2

Comparative analysis of the largest Arctic cities

	Norilsk	Murmansk	Arkhangelsk	Severodvinsk	Novyy Urengoy	Noyabrsk
It is an agglomeration center	Yes	Yes	Yes	No, it is part of the Arkhangelsk agglomeration	Yes	Yes
Located in an area with limited delivery	Yes	No	No	No	No	No

time/no year-round road net-work that connects to the mainland						
Year-round railway inte-grated into the national network	No	Yes	Yes	Yes	Yes	Yes
Specializatio n	Single-industry (mining)	Administrative center	Administrative center	Single-industry (processing)	Single-industry (mining)	Single-industry (mining)
City-airport distance	39 km	33 km	14 km	38 km	7 km	19 km
City-sea/river port distance	91 km	In the city	In the city	In the city	No port	No port

Fig. 1. Spatial structure of the Norilsk agglomeration [10].

The Norilsk agglomeration in its current form emerged, one could say, by accident: in the current rotational model of mining development, the center cannot grow to the size of an administrative center. This was the result, on the one hand, of the Soviet industrial model of development of the North, which in the third Kondratiev was aimed at populating uninhabited spaces with stationary cities and towns; on the other hand, the super-richness of the Norilsk deposits, which made it possible to shift mining sites over the course of a hundred years, but not radically change the location of the city itself, preserving it without radical compression and turning it into a rotational city. There were deposits of energy and life-sustaining resources next to the unique Norilsk multicomponent ores — first, Taimyr coal was used, then, from the 1960s, the resources of the gas fields of Western Taimyr. This made it possible to relatively easily solve the most important issue of heat and power supply for a large Arctic city. The Norilsk agglomeration took shape from the very first decades of development of the Norilsk industrial area, however, the nature and intensity of connections between the structural elements of this agglomeration certainly changed over time.

[10] Source: Google Earth.

The agglomeration effect can work on the modern transformation of Norilsk from a single-industry city to a base city for the development of the Eastern Arctic. This requires systemic efforts from all structural elements of the Norilsk agglomeration — Norilsk itself (see section 3), the seaport of Dudinka and Alykel airport, transforming them from purely corporate into basic ones for Russia's development of its eastern Arctic.

The turn of Norilsk from a single-industry into the central city of the eastern Arctic is impossible without a simultaneous turn of the port of Dudinka to a broader specialization in servicing the cargo of "new Kara expeditions", and more broadly speaking, commercial and social cargo flowing from the trans-Siberian depths of Siberia along the Yenisei in the direction of the eastern Arctic. Today, the Murmansk–Anadyr–Vanino route, which dominates in terms of cargo traffic in the maritime Arctic, should be diversified by the Yenisei–NSR route.

In Dudinka, it is advisable to create an eastern transport and logistics hub for warehousing and transshipment of transit container cargo, internal cabotage, including budgetary cargo, formation of maritime service complex companies that carry out repairs, supplies and bunkering of ships, and in the future — construction of a new shipyard in Dudinka, using the competencies of Norilsk engineers.

Another event is the inclusion of Alykel airport in the core aviation transport network of Siberia and the Far East with a radical expansion of the geography of flights through the airport inside Taimyr, to neighboring Yakutia and the Chukotka Autonomous Okrug, the establishment of a charter flight Norilsk–Tiksi–Pevek (Keperveem)–Anadyr, which will be co-financed by all participating regions. After all, in the entire space up to Anadyr, there is simply no airport of similar scale capable of performing the functions of air communication integration. NK Rosneft and MMC Norilsk Nickel have already agreed on the joint use of airport infrastructure, on the creation of a new service center to service rotational personnel and aviation equipment for the Rosneft Vostok Oil project (the air route of the Norilsk–Dikson–Bay North project is already operating). In the near future, a change in the airport's operating hours and a transition to a 24-hour format is being considered, which will expand the reception time for aircraft [11]. But we should talk about an even greater expansion of the service functions of the Alykel airport and the Dudinka seaport in the interests of liberating the forces of the agglomeration effect to transform Norilsk into the base city for the development of the Eastern Arctic.

3. Structural shifts within the city's economy to consolidate the role of Norilsk as a supporting (base) city of the Eastern Arctic

Effective performance of the functions of a support base for the development of the Eastern Arctic, which is associated with overcoming the modern single-industry status of Norilsk, will require deep structural changes in the city's economy that are in line with the fifth technological

[11] Rabotu aeroporta Noril'ska planiruyut sdelat' kruglosutochnoy [It is planned to operate the Norilsk airport around the clock]. URL: https://tass.ru/ekonomika/18230315 (accessed 08 August 2023).

order: increasing the role of knowledge-intensive production services, areas of application of artificial intelligence and the Internet of things, digitalization of municipal management processes and etc. The unity of transformations of external, agglomeration connections (see section 2) and internal connections in the city economy itself ensures the success of the strategy of gaining "centrality" for Norilsk.

The first direction is strengthening and increasing practice orientation in the work of the city scientific and educational complex (city innovation system), the core of which is the N.M. Fedorovsky Polar University. Norilsk is the only city in the eastern Arctic that has its own university, not a branch. Therefore, the concentration of Arctic engineering competences, design and construction in the conditions of "melting" permafrost, and monitoring of the condition of buildings and structures in the warming Arctic [12] is non-alternative.

However, it would be wrong to reduce its entire long-term development only to the development and implementation of engineering and technical solutions that ensure the sustainable functioning of social and engineering infrastructure facilities in the context of climate change. The development strategy of the Polar State University until 2035 should be extremely ambitious and firmly aligned with the priorities of turning Norilsk into a supporting city of the Eastern Arctic, that is, with solving the problems of modern life support for Arctic settlements, organizing production services for resource companies operating in this territory (in Taimyr, Evenkia, Yakutia and Chukotka), Arctic cruise tourism projects, etc. The following scheme is considered: the accumulation of Arctic competencies at the university, the selection of the most advanced and effective, their replication in the settlements of the Eastern Arctic.

The second direction of the structural transformation of the city economy, which strengthens the basic functions of Norilsk, is the formation of an entrepreneurial layer in new industries and types of economic activity. According to formal indicators of entrepreneurship development, the city occupies the last position among large and medium-sized cities in the Russian Arctic. However, the point is not even a lag in the level of development of entrepreneurship, but the fact that trade entrepreneurship dominates among small and medium-sized businesses, and for the purposes of supporting Norilsk, more production entrepreneurship and firms in the industrial segment are needed. For example, the creation in Norilsk, with the participation of Rosgeologia, of a private junior mining business for prospecting and exploration of new mineral deposits in Taimyr, Evenkia, and the eastern Arctic.

Such a large industrial center as Norilsk, with engineering competencies accumulated over decades, will not be able to establish its stronghold without the formation of a layer of small and medium-sized manufacturing industries in new areas, for example, the environmental industry:

[12] The task of creating a research center for construction technologies and monitoring the condition of buildings and structures in the northern and Arctic territories in Norilsk is set in the Strategy for Developing the Russian Arctic Zone and Ensuring National Security until 2035 (as amended by the Decree of the President of the Russian Federation dated December 11, 2021 No. 651). We believe that it is advisable to create it under the auspices of the Polar State University.

enterprises for processing scrap metal, old tires, production of building materials with adding sulfur (for example, sulfur concrete), building blocks, production of energy-saving equipment, etc.

The third direction of the structural transformation of the city economy is the entrance of the production service structures, which are located inside the Norilsk Nickel plant, together with Norilsk entrepreneurs, to the wider market of Taimyr and its new projects, the entire eastern Arctic.

For example, several large projects for new economic development will be implemented in Taimyr until 2035 (Fig. 2): the project for the development of the Chernogorskoe platinoid deposit of Russian Platinum, the northern part of the Vankor oil cluster of Rosneft (the Ust-Yenisei oil production center of the Independent Oil and Gas Company), a project for the development of the Syradasay coal deposit AEON, exploration work with the potential for transition to the economic activity of NovaTEK, Gazpromneft, Surgutneftegaz and Lukoil [13]. At least a dozen new projects will be launched in the forecast period in Yakutia and the Chukotka Autonomous Okrug (Table 3).

In terms of turning Norilsk into a supporting, base city for the development of the Eastern Arctic, it is proposed to see all these projects as a potential market for production service companies of the city and the plant. Many of the works that are currently performed by the service departments of Norilsk Nickel (Table 3) can be performed not only for the plant, but also for a wide range of resource companies operating in the eastern Arctic. After all, there are simply no specialists in the Eastern Arctic who are more familiar with the Arctic specifics than those in these structures.

There should be a strengthening not only in matters of geographic expansion, but also in the range of services offered (as technologically advanced as possible) for settlements and projects in the eastern Arctic: for example, the dissemination of best practices in the use of lidar scanners on drones for laser scanning of the earth's surface [14], transition for LNG fuel when using heavy mining equipment [15], developing the institution of free prior informed consent (FPIC) when interacting with local residents during the implementation of new mining projects [16]. Federal policy in the Eastern Arctic should encourage the rapid replication of this experience by the structures of the plant and Norilsk small businesses in mining companies and settlements in Taimyr, Evenkia, Yakutia and Chukotka.

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[13] Strategiya sotsial'no-ekonomicheskogo razvitiya munitsipal'nogo obrazovaniya gorod Noril'sk do 2035 goda kak opornogo goroda Arktiki (vostochnoy Arktiki). Utverzhdena resheniem Noril'skogo gorodskogo Soveta deputatov ot 20 iyunya 2023 goda № 8/6–193 [Strategy for the socio-economic development of the municipality of Norilsk until 2035 as a supporting city of the Arctic (Eastern Arctic). Approved by decision of the Norilsk City Council of Deputies dated June 20, 2023 No. 8/6–193]. URL: https://norilsk.ru/files/50741/83786/strategiya_2035.pdf (accessed 08 August 2023).

[14] «Nornikel'» vnedril mobil'nye lidarnye skanery na rudnikakh v Noril'skom divizione [Norilsk Nickel has introduced mobile lidar scanners at mines in the Norilsk division]. URL: https://www.comnews.ru/digital-economy/content/222286/2022-09-22/2022-w38/nornikel-vnedril-mobilnye-lidarnye-skanery-rudnikakh-norilskom-divizione (accessed 08 August 2023).

[15] «Nornikel'» v 2022–2023 godakh postroit zavod po proizvodstvu SPG v Noril'ske [Norilsk Nickel will build an LNG production plant in Norilsk in 2022–2023]. URL: https://tass.ru/ekonomika/10656647 (accessed 08 August 2023).

[16] «Nornikel'» zavershit stroitel'stvo poselka na severe Krasnoyarskogo kraya v 2026 godu [Norilsk Nickel will complete the construction of a village in the north of the Krasnoyarsk Krai in 2026]. URL: https://tass.ru/ekonomika/15648581 (accessed 08 August 2023).

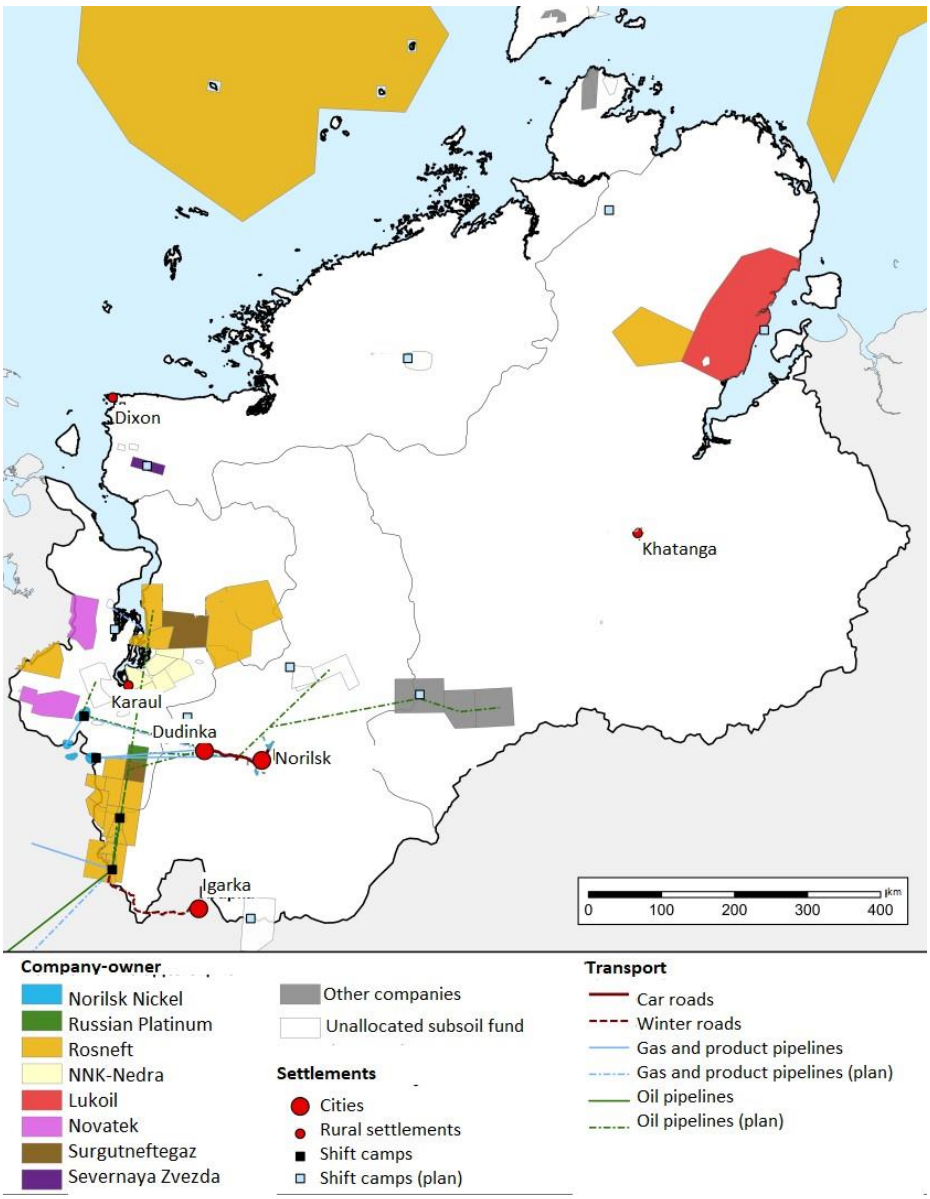

Fig. 2. Distribution of licensed areas of key companies in the Taimyr Dolgano-Nenets district [17].

Table 3

Norilsk supply and demand for production service structures of Eastern Arctic projects [18]

Production service structures — divisions of Norilsk Nickel	Types of work performed	Eastern Arctic projects — potential markets for Norilsk production services
Polar Construction Company LLC	Complex of general construction works: geodetic, mining preparation, tunneling, excavation, drilling and blasting, installation, electrical installation, commissioning, repair and construction, sanitary and finishing work of a wide, universal profile (over 3 thousand people).	Chukotka: Baimskiy copper ore project Beringovskiy coal project Pyrkakaysko-Mayskiy ore project Projects of gold and silver deposits Valunistoe, Kekura, Karalveem and others. Yakutia: Tomtorskiy rare earth project, Taymylyrskiy coal project, Zyryanskiy coal project, etc.
Norilsknickelremont LLC	Maintenance and repair of fixed assets of metallurgical plants and processing plants, power plants, electric motors and transformers, shut-off valves, self-	

[17] Cartography by B.V. Nikitin, graduate student of Lomonosov Moscow State University.
[18] In characterizing the profile of activities of the production service structures of Norilsk Nickel, data from the company's annual reports are used.

	propelled diesel equipment, automotive equipment; lifting machines and road construction mechanisms; rolling stock, mechanical and technological equipment, railway and crane tracks, electrical equipment and communication lines, as well as instrumentation, computer equipment. Production of metal structures, rubber products from polyurethane, polypropylene, production of building materials – polystyrene concrete, polymer concrete, rust converter, carpentry, etc. (over 10.1 thousand people).	
Norilsk Supply Complex LLC	Production of finished metal products, non-metallic products, woodworking.	
Scrap Metal Processing Plant LLC	Activities for the collection, processing and sale of scrap ferrous and non-ferrous metals generated after dismantling	
Norilsk Nickel Technical Services LLC	Geological exploration, geophysical and geochemical work in the field of subsoil study and reproduction of the mineral resource base.	
Norilskgeologia LLC	Search and exploration of deposits of nickel, copper, platinum group metals and non-metallic technological raw materials on the territory of the Taimyr Peninsula and in adjacent areas	
Vostokgeologia LLC	Search and exploration of deposits of copper, gold and molybdenum in southeastern Siberia and the Far East	
Geocomp LLC	Search and exploration of nickel and copper deposits in the southern part of central Siberia and the Taimyr Peninsula	

4. Key mechanisms for implementing the Norilsk support strategy

There is long-standing competition in the Russian European Arctic for the role of a key development base between Murmansk and Arkhangelsk, but in the Asian Arctic no one has yet even nominated a candidate city for this role [19]. In terms of size, Norilsk is the undisputed (monopoly) leader. The limiting factor to become a supporting base city is the distance from water (river and sea) routes, which is overcome when the port of Dudinka is depressurized; its cut-off from the national network of land roads, which is partially neutralized when Alykel airport turns to resource projects and settlements in the eastern Arctic (Taimyr, Evenkia, Yakutia and Chukotka) — which is already starting to happen, for example, as a result of agreements between Rosneft and Norilsk Nickel. For Norilsk, these processes mean that it can only become a base for the Eastern Arctic by fully utilizing the effect of the Norilsk–Dudinka–Alykel agglomeration.

The most important political and economic condition for the transformation of Norilsk into a supporting city of the Eastern Arctic for Russia is the “mirror strategy” of the actions of the city and the plant in the Eastern Arctic. The paradox is that overcoming the single-industry nature of

[19] Pilyasov A.N. Noril'sk mozhet stat' stolitsey vsey aziatskoy Arktiki [Norilsk can become the capital of the entire Asian Arctic]. Interview. Newspaper "Oxygen.Life". February 24, 2021. URL: https://kislorod.life/opinions/norilsk_mozhet_stat_stolitsey_vsey_aziatskoy_arktiki/ (accessed 01 July 2023).

the city and acquiring the functions of a capital city is only possible through joint actions with the city-forming enterprise, which created the single-industry nature of Norilsk over a hundred years of economic history. But it is simply impossible to do otherwise in a situation where more than a quarter of the city's population —employees of the plant's divisions.

It is proposed to develop such a "mirror strategy" for the long-term actions of the city and the plant in the eastern Arctic and coordinate it with the relevant ministries of the Government of the Russian Federation (primarily the Ministry of Natural Resources, the Ministry of Economic Development and the Ministry of Eastern Development of Russia). According to this strategy, on the one hand, the city "follows" the company to the places of its new location and its divisions: for example, the Trans-Baikal Territory (Bystrinskiy project), Magadan Oblast (the Polyus-Gold project for the development of the Natalka gold deposit). It is logical to conclude cooperation agreements and even twinning between Norilsk and Chita, Norilsk and Magadan.

On the other hand, the potential expansion of Norilsk in the eastern Arctic should necessarily take into account the interests of Norilsk Nickel. Therefore, it is advisable for the city and the company to jointly approach the federal government of the Russian Federation with an initiative to give Norilsk Nickel the opportunity to participate in the acquisition of licenses for subsoil areas along the Arctic front of Russia east of Taimyr, thereby updating the corporate regional effect [21]. Then the city's ambitions for a stronghold in the eastern Arctic will be supported by the power of the company, which will also carry out its own expansion into promising mining projects east of Taimyr. In this case, there will be a constructive synergy between the city and the company for the interests of the country, but outside the single-industry city — in the entire Eastern Arctic.

In the news of recent months, one can see how some elements of this strategy are already beginning to be implemented by the plant. The head of Norilsk Nickel, V. Potanin, announced a restructuring of the company's investment policy — from expansion into foreign markets to an emphasis on Russia [20]. Our proposed strategy for the plant's expanded presence in the eastern Arctic is fully consistent with this new priority. New close interaction between the city and the plant is ensured in the recently adopted Comprehensive plan for the social and economic development of Norilsk until 2035 [21].

Thus, the novelty of our approach in approving the "mirror strategy" of the city and the plant is that it goes beyond the city's contours, the entire eastern Arctic becomes its scope of action (more precisely, we argue that 1) the joint efforts of the city and the plant on the outer contour the eastern Arctic will bring both partners more benefits than scattered actions in this direc-

[20] Potanin zayavil, chto «Nornikel'» perestroit investitsionnuyu politiku s aktsentom na Rossiyu [Potanin said that Norilsk Nickel will rebuild its investment policy with an emphasis on Russia]. URL: https://tass.ru/ekonomika/16858345 (accessed 08 August 2023).
[21] Rasporyazhenie Pravitel'stva RF ot 10 dekabrya 2021 goda № 3528-r [Order of the Government of the Russian Federation of December 10, 2021 No. 3528-r]. URL: http://publication.pravo.gov.ru/Document/View/0001202112140024 (accessed 08 August 2023).

tion; 2) the focus on Russia "in all azimuths", which is already starting to happen [22], is less constructive for the plant than a targeted joint strategy with the city for actions in the eastern Arctic). Such a coordinated strategy of action turns out to be in the interests of the country, the city and the plant itself.

The realities of the modern development of the Russian Arctic are such that Rosatom has already de facto received the status of a superorganization in this process, which officially, according to the Decree of the President of the Russian Federation, became the infrastructure operator of the Northern Sea Route. Rosatom has created a powerful Arctic division and accepted responsibility for the delivery of budgetary cargo via the NSR; for the integrated transport and energy development of a number of new Arctic projects (escorting cargo ships with nuclear icebreakers and power supply to floating nuclear power plants and other low-power nuclear power plants); it has also started to develop the new Pavlovskoe ore deposit on Novaya Zemlya.

Therefore, the expansion of Norilsk Nickel's activity in the eastern Arctic inevitably presupposes the conclusion of a partnership agreement with Rosatom. This is already happening in a narrow format: Norilsk Nickel plans to conclude an agreement on the nuclear icebreaker Sibir of project 22220 until 2041 "for icebreaking support of ships providing cargo transportation for the implementation of the Southern Cluster projects, increasing the capacity of the Talnakh enrichment plant, implementing "Sulfur program" and the main activities of the enterprise in the Norilsk industrial region" [23]. In a narrow format, there is cooperation on the development of the Kolmozerskoe lithium deposit in the Murmansk Oblast — it is planned to create a joint venture between Rosatom State Corporation and MMC Norilsk Nickel [24]. Norilsk Nickel and Rosneft agreed on a fuel supply system in the north of the Krasnoyarsk Krai, which guarantees the sustainability of gas supply to the Norilsk industrial region in conditions when Rosneft received at auctions the new Deryabinskiy and Turkovskiy sections of the Taimyr oil and gas field (which Norilsk Nickel had previously claimed) [25].

However, as in many other cases of interaction between the plant and the city, the plant and Rosatom, the plant and Rosneft, in the interests of the country and the dynamic development of Norilsk, a significantly wider format of interaction between the main actors is needed than is currently accepted — for the purpose of constructive guardianship of the exploration and devel-

[22] For example, the expansion of Norilsk Nickel's subsidiary in the Yamal-Nenets Autonomous Okrug. URL: https://tass.ru/ekonomika/15951241 (accessed 08 August 2023).
[23] «Nornikel'» planiruet zaklyuchit' dogovor na atomnyy ledokol «Sibir'» do 2041 goda [Norilsk Nickel plans to conclude a contract for the nuclear icebreaker Sibir until 2041]. URL: https://tass.ru/ekonomika/16455795 (accessed 08 August 2023).
[24] «Nornikel'» v 2022–2023 godakh postroit zavod po proizvodstvu SPG v Noril'ske [Norilsk Nickel will build an LNG production plant in Norilsk in 2022–2023]. URL: https://tass.ru/ekonomika/10656647 (accessed 08 August 2023).
[25] Vostok Oyl vyigrala auktsiony na Turkovskiy i Deryabinskiy uchastki nedr na p-ve Taymyr [Vostok Oil won the auctions for the Turkovskiy and Deryabinskiy subsoil blocks on the Taimyr Peninsula]. URL: https://neftegaz.ru/news/gosreg/675810-vostok-oyl-vyigrala-auktsiony-na-turkovskiy-i-deryabinskiy-uchastki-nedr-na-p-ve-taymyr/ (accessed 08 August 2023).

opment of the territories of the Eastern Arctic by the largest corporate player here, represented by Nornickel, and the largest city of Norilsk.

The large-scale agreement between Norilsk Nickel and Rosatom is all the more important because the state corporation is gradually moving to a project-oriented model of using icebreakers, when each of them will be assigned not to a water area, but to a specific project (localized group of projects) [26]. It will be impossible to carry out effective supervision of projects and settlements in the Eastern Arctic without coordination of these plans not only with the relevant federal ministries, but also with Rosatom. In the context of this strategic line, it is advisable to propose Norilsk as a location for the headquarters of private and public companies operating in the eastern Arctic: Rosatom, Rosneft, Roscosmos, NovaTEK, etc.

Another promising way for the Russian Federation to strengthen Norilsk's centrality in the eastern Arctic is to provide security services, civilian and military. Norilsk can become a consolidating force in the efforts of the Ministry of Emergency Situations to create crisis management centers and emergency rescue units in Dudinka in Krasnoyarsk, Tiksi in Yakutia, and Pevek in Chukotka.

Separately, all these cities are already involved by the Ministry of Emergency Situations in the comprehensive security system to protect the territories and population of the eastern Arctic zone from emergencies of natural, human and military origin. But we are talking about the headquarters of the EMERCOM services for the Eastern Arctic (the center of the EMERCOM network of territorial Arctic units) being located in Norilsk as the largest and most technically equipped city in the Eastern Arctic. It is here that the training of professional rescuers with Arctic specifics capable of conducting long-term effective search and rescue operations in the Arctic seas and on land would be organized. In the future, part of the government functions should be transferred to Norilsk as a city of federal significance as a result of the creation of federal service units here — not only the Ministry of Emergency Situations, but also the Ministry of Defense, the State Duma, a number of federal ministries and Roshydromet.

Another direction for combining the efforts of all territories of the Eastern Arctic is the establishment of Arctic cruise tourism here from Dudinka to Anadyr, including through scaling the positive Norilsk experience of creating the "Arctic" tourist and recreational cluster [27] (Norilsk is the center of cultural, educational and industrial tourism, Dudinka is the center of event and ethnographic tourism, Putorana plateau — extreme and ecological one) to Chukotka Pevek, Provideniya and Anadyr (and such a task is set in the program documents of the Chukotka Autonomous Okrug).

[26] Rosatom zayavil o neobkhodimosti po-novomu ispol'zovat' ledokoly iz-za rosta nagruzki na SMP [Rosatom announced the need to use icebreakers in a new way due to the growing load on the Northern Sea Route]. URL: https://tass.ru/ekonomika/16622923 (accessed 08 August 2023).

[27] Turistsko-rekreatsionnyy klaster «Arkticheskiy» mozhet byt' rasshiren za schet Evenkii [The "Arctic" tourist and recreational cluster can be expanded to include Evenkia]. URL: https://tass.ru/ekonomika/12226537 (accessed 08 August 2023).

Due to an objective crisis situation in the city's housing and communal services, Norilsk was forced to begin a radical renovation of the housing stock and the entire city's public utilities earlier than other cities and towns in the Eastern Arctic. The positive element is that in order to strengthen the basic functions of the city in the eastern Arctic, it is necessary to accumulate positive experience in the reconstruction of the urban economy for its subsequent "relay race" transfer to the east further — to the villages of Yakutia, the cities and towns of the Chukotka Autonomous Okrug. For example, the transition from the plaster facade of residential buildings to curtain wall facade technologies as more energy efficient and durable [28].

Natural recognition of Norilsk's success in becoming a pivotal city of the Eastern Arctic will be an increase in its administrative status — transformation into a city of federal significance. In essence, this means a radical transformation of Norilsk from a closed island local single-industry city into an Arctic center of federal and global significance open to the world.

Technically, this means a systematic and multilateral positioning of the city on numerous international platforms, the intensification of freight transportation through the Yenisei–NSR system, including export "deep Siberian" cargo intended for the Asia-Pacific markets (for example, grain) [29]; liberation of the export potential of local small businesses and a multiple increase in the export products of Norilsk entrepreneurs and the number of export-oriented small and medium-sized businesses.

In the Arctic of Asia, which is entirely Russian (unlike the Arctic of Europe), it is advisable to organize a regular conference — an analogue of the "Arctic Frontiers", which is held every two years in Tromsø, Norway, for the Arctic territories of Europe and America. Norilsk could become a platform for regular holding of the "Arctic Frontiers of Asia", using its twinning ties with Asian cities both in its north, in Russia, and in its south, in China, India, and Iran.

The city will be the bridge that connects Russian Arctic Asia and south/southeast Asia at this regular forum. It would be advisable to locate visa centers in the city for leading Asian countries, which today act as markets for Norilsk Nickel products. They are also capable of becoming tourist markets for the main recreational destinations of Norilsk and its environs in the "Arctic" tourist and recreational cluster. The creation of visa centers for Asian countries in the city will simplify travel for the plant's employees and intensify contacts between city entrepreneurs, experts, and managers with partners from Asian countries. A container terminal for Asia-Europe transit

[28] Renovatsiyu zhil'ya v Noril'ske budut provodit' tekhnologiey navesnykh fasadov [Housing renovation in Norilsk will be carried out using curtain facade technology]. URL: https://tass.ru/nedvizhimost/11797355 (accessed 08 August 2023).

[29] Strategiya sotsial'no-ekonomicheskogo razvitiya munitsipal'nogo obrazovaniya gorod Noril'sk do 2035 goda kak opornogo goroda Arktiki (vostochnoy Arktiki). Utverzhdena resheniem Noril'skogo gorodskogo Soveta deputatov ot 20 iyunya 2023 goda № 8/6–193 [Strategy for the socio-economic development of the municipal formation of Norilsk until 2035 as a supporting city of the Arctic (Eastern Arctic). Approved by decision of the Norilsk City Council of Deputies dated June 20, 2023 No. 8/6–193]. URL: https://norilsk.ru/files/50741/83786/strategiya_2035.pdf (accessed 08 August 2023).

cargo will be created in Dudinka; Alykel will actually become an international airport connecting Norilsk with Asian countries.

Discussion and conclusions

It may seem strange that, given the urgent need for the country, its Arctic zone, Norilsk itself to become the central city of the eastern Arctic from a single-industry city, there is no clear discussion of this topic either on the platforms of federal executive bodies, or in the chambers of the federal parliament, or in strategic documents planning the development of the Arctic zone of the Russian Federation. It seems that part of the explanation lies in the "triple lock" phenomenon of this idea.

Firstly, the federal authorities do not see Norilsk as a supporting base for the development of the Eastern Arctic because such a base is traditionally sought in the Far Eastern Federal District (in Soviet times there were such bases for the development of the "Far North", but in the south — Khabarovsk, Vladivostok, Magadan). However, now we are talking about a large Arctic development base in the Arctic itself — similar to Murmansk and Arkhangelsk, but in the east. But in the Far Eastern Arctic, in the North-East of Russia, there is simply no such large base city. Therefore, there is no topic of searching for a base city for the Eastern Arctic, since it simply does not exist in the Far Eastern Arctic. And Norilsk is not part of the Far Eastern Federal District (together with the Krasnoyarsk Krai, it is in the Siberian Federal District), so it simply does not participate in this search for a base "from the outside" of the Far Eastern Federal District. Indeed, why look for a base city for the eastern Arctic (Taimyr, Yakutia, Chukotka), which is mainly included in the Far Eastern Federal District, outside the Far Eastern Federal District.

Secondly, the city-forming Norilsk Combine does not see Norilsk outside the role of its single-industry city. It agrees to participate in the improvement of the city and the comfort of the urban environment, but cannot even imagine that the city could have "external" administrative ambitions for guardianship and patronage over the eastern Arctic. In the current situation they are the saving grace for the city, because they give it a new impetus for development, which it can no longer receive from within: due to the technological modernization of the plant, the number of employees will be steadily declining.

Thirdly, both Dudinka and Alykel, without which the implementation of the centrality of Norilsk in the eastern Arctic is impossible, have traditionally been "hermetically" specialized to the needs of the plant, which were exclusively limited to economic ties with Europe, and not with the eastern Arctic (neither Dudinka nor Alykel fully worked with the eastern Arctic). The first year-round flight along the NSR was organized in the Soviet years precisely in a western direction — to export Norilsk concentrate to Murmansk. And in the eastern Arctic, the basic role of Murmansk was fixed, from which sea deliveries to the North and icebreaker support of convoys of ships to Anadyr were carried out.

This triple blocking closed the possibility of discussing new prospects for Norilsk for many years — outside the traditional role of the city at the plant.

A "methodological" question may arise about the priority of solving the problems of acquiring Norilsk functions of Taimyr, zonal (for the eastern Arctic) and national (for the countries of South Asia) support. In the ideology of the industrial era, with its accepted linear "conveyor" scheme for obtaining results, we could only talk about a consistent movement from task to task, about a kind of gradual ascent of Norilsk to the status of a city of federal significance, a global city.

But in the new times, when modern projects of NovaTEK and Gazprom Neft in the Arctic are being implemented in the logic of simultaneous parallel movement in construction at an accelerated rate, in several directions at once, and then final assembly on site from ready-made block modules, the requirements for gradual ascent are not mandatory. It is necessary to begin work in all three directions at the same time, find overlaps between them, prepare the city to overcome its previous single-industry status, turning into a supporting city-center that performs new functions of integral support.

This is a triune task that should be solved jointly: by acquiring the functions of a Taimyr support, Norilsk is preparing itself for a full-fledged role as a base for the development of the entire eastern Arctic; and this role, in turn, puts Norilsk on the pedestal of a city of federal significance/global city, performing the most important national functions in Asia [30].

It will be extremely difficult to implement the described plan for the ascent of Norilsk from a single-industry city to the only city of federal significance in the Arctic, the support base for the development of the eastern Arctic. After all, this completely contradicts the entire inherited trajectory of development of the city, the industrial one, to which several generations of Norilsk residents have become accustomed over a hundred years of development. Only new people who are not attached to the plant and are very brave, but who have powerful and long-term support from the federal center, which has "put their money" on Norilsk, will be able to implement this scenario. A more comfortable and routine alternative: the usual picture of the development of the city under the plant, slightly improved by the large-scale modernization of the city's utilities and social sphere.

In this article, the author wanted to outline the upper limit of possible and completely justified claims of Norilsk, without any illusions about the ease of implementing the Norilsk city superproject "a leap from the realm of single-industry to the realm of centrality in the Asian Arctic".

[30] Strategiya sotsial'no-ekonomicheskogo razvitiya munitsipal'nogo obrazovaniya gorod Noril'sk do 2035 goda kak opornogo goroda Arktiki (vostochnoy Arktiki). Utverzhdena resheniem Noril'skogo gorodskogo Soveta deputatov ot 20 iyunya 2023 goda № 8/6–193 [Strategy for the socio-economic development of the municipal formation of Norilsk until 2035 as a supporting city of the Arctic (Eastern Arctic). Approved by decision of the Norilsk City Council of Deputies dated June 20, 2023 No. 8/6–193]. URL: https://norilsk.ru/files/50741/83786/strategiya_2035.pdf (accessed 08 August 2023).

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