A conceptual framework of logistics infrastructure for implementing the circular economy model in the Russian Arctic

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Abstract. This article aims to show the fundamental importance of logistics for the sustainable development of the Russian Arctic. The results of theoretical research are presented herein should be of interest for assessing and implementing the concept of sustainable development in the Arctic. The expanded interpretation of logistics as science and technology for creating and managing logistics flows of different nature is given. The holistic approach – based on the marketing ecology concept – for designing a research framework of sustainable logistics infrastructure is substantiated. A draft map of the air layer in the hypothetical sustainable logistics infrastructure of the Arctic is presented and briefly described.

1. Introduction

The development of such a vast territory as the Russian Arctic (the contemporary official name since 2014 is the Arctic zone of the Russian Federation - AZRF). In contemporary conditions, compliance with the imperative of sustainable development of Russian Arctic is a strategic challenge for developing the economic and defense potential necessary for the continued existence and development of Russia as a whole. From an economic point of view, the contribution of the Russian Arctic to Russia's GDP is more than 10% (more than 20% of Russian exports – mainly due gas/oil production) while its population is only about 2% of the population of Russian Federation [1]. Note that these figures can be considered accurate only to a certain extent due to incompleteness of regional statistics.

The fact is that the legislative proposal to distinguish the Russian Arctic as a separate object of statistical observation was first made only in 2014. In addition, since that time, not only the environmental and socio-economic characteristics of this Russian megaregion [2] but its borders have undergone changes. This Arctic megaregion is also no less important for the defence of Russia and its geopolitics [3]. By analogy with the so-called “soft underbelly” on the southern borders of Russia the said megaregion could be called as the “Arctic spine” of Russia (the largest Arctic coastline, more than 10,800 miles long), the fortress of which ensures its defenses. It was just here that during the Cold War there was a constant patrol of nuclear submarines and strategic bombers (USSR versus USA). Unfortunately, it seems the same situation is revitalized now due to the contemporary aggravation of geopolitical rivalry and controversial issues regarding the natural resources of the Arctic [4]. Nowadays, the Arctic is in focus of interests of not only other circumpolar Nations from so-called the “Arctic Eight”...
(Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden and United States), but other Nations located rather far from borders of the said region: other EU-countries and certain countries of the Asia-Pacific Region. Even China, being thousands of miles distant from the Arctic, expresses its interest in this region [5]. Recall that China received (2013) the observer status within the Arctic Council. Besides, the great interest to the resource and military importance of Arctic is explicitly shown by EU and NATO [6]. The Arctic policy of European Union can be presented as follows [7]: “Arctic policy development in the EU may be accounted for as being a response to systemic change, where the Union seeks to protect its interests in a region of increasingly higher stakes in matters of wealth and security”. However, Russia began the development of its polar region approximately eight centuries ago and they consider the Russian Arctic (part of the borders of which is not conveniently recognized in the all world) as an integral part of the Russian geopolitical space. Despite the well-known thesis (in “Vom Kriege” by Carl von Clausewitz about the war as the “continuation of politics by other (namely: violent) means”) no military operations are considered as a tool for resolving contradictions in the Arctic. Not military, but economic power should ensure national sovereignty (if any) outside the 12-mile zone of territorial waters. This suggestion could be supported by a very suitable title in The Economist (NOV06, 2017): “Where economic power goes, political power will follow”. An undeniable argument in favor of common recognizing Russian power in the Arctic should be well-established Russian logistics and rescue services based on the Northern Sea Route.

In the twenty-first century, the concept of sustainable development is – from the very beginning of its official appearance in front of urbi et orbi as the Brundtland Report presented in 1986 [8] – not an option but the threefold imperative [9] comprising of (1) satisfying needs (of businesses, individuals, communities and societies as a whole); (2) ensuring social equity; and (3) respecting environmental limits. These three components of the said imperative remind almost the same that was represented [10] as the 3P-paradigm “Profit-People-Planet”. Three facets of the said imperative have the same sources to be satisfied, such as four capitals (manufactured or built, human, social, natural capital) [12] that are compatible and their development requires a properly designed infrastructure. The term “infrastructure” is now very popular (1,390,000 responses in Google at February 2020) because infrastructures play the same role as motherboards in computers – creation of a properly functioning stable system from interconnected subsystems of various levels. A set of infrastructure definitions concerning economic development was revealed [12] and part of them will be used herein further. More specified term “socio-economic infrastructure” (231,000 Google responses) is understood as sets of physical (economic) structures of various types such as network utilities (energy, water, transport, and digital communications) interconnected with sets of social infrastructure (institutes) such as education and health systems which together must ensure the successful development of national economy [13]. Socio-economic infrastructure is a prerequisite for the development of any economy and the inadequate-to-sustainability socio-economic infrastructure negatively impacts on economic growth and quality of life [14]. The following statement sounds quite corny [15] but the need of focusing on sustainable infrastructure development, both globally and in Arctic, has become much more significant than decades ago.

Taking into account the environmental vulnerability of the Arctic region [16] it can be said that the concept of sustainable development and the linear economy model are absolutely incompatible things. The concept of sustainable development to be implemented requires substantial changes in current linear economic model well-described by following formula: “take” ⇒ “make” ⇒ “dispose”. In the case of Arctic, in matters relating to the livelihood and working activities of the people working there, the “take” means today the rather long supply chains with corresponding high logistics transaction costs and risks followed by technogenic impacts on Arctic environment; the “make” means a production and persona consumption of inputs delivered by the said supply chains and (without special solutions) anthropogenic and additional technogenic impacts on Arctic environment; finally, “waste” means deteriorating Arctic environment and sometimes needs to arrange reverse logistics flaws. The said reverse logistics is to be arrange due to emerging by-products of production system activities (e.g., returnable packaging, flawed items, and units that become out of operation) which can create a significant threat to the ecosystem of the Arctic [17]. On one hand, the reverse logistics protects the
Arctic environment but on the other hand the reverse logistics per se creates additional negative impacts on the same environment. The Arctic environmental anthropogenic/technogenic vulnerability [18] is multidimensional one; for example, (1) pollutants in the Arctic tend to persist for long periods of time in the environment and pose health risks to local ecosystems and humans [19]; (2) Arctic industrial activities (shipping and exploration of resources) are potential sources of negative impacts on the local environment [20]; and (3) local pollutants from industrial activities in the Arctic could lead to increased pollutant concentrations in the environment and bioaccumulation in food chains [ibid]. Therefore, it can be finally said that the concept of sustainable development and the linear economy model that has been practiced for many years are incompatible things.

The model of circular economy has emerged as an alternative model, given its potential for business, while generating social and environmental positive impacts. Among the three economic models whose purpose is to realize the concept of sustainable development – green economy [21], bio-economy [22], and circular economy – it is the model of circular economy that, to our mind, is best suited for implementing the concept of sustainable development in the Arctic. The said model is factually a replica of natural ecosystems where the 5R-paradigme (Reduce + Reuse + Renew + Repair + Recycle) [23] has been realized “by the will of God”. The architecture of the said model reminds a set of food chains inside a natural trophic structure where wastes of i-level serve as inputs for one or more (i+1)-levels of the said structure. Inside the said structure products have reached the end of their useful life, become either "biological nutrients" or "technical nutrients" [24] that is the crucial for creating and maintaining sustainable production and consumption systems. It is the reason why a pair of notions borrowed from non-economic disciplines concerning the alive nature – “industrial symbiosis” [25] and “socio-economic metabolism” [26, p. 9-10] that are so popular in discussions about the circular economy. There should be no doubt that without a strategy to guide different infrastructure projects the Arctic region will simply drift directionless in the "sea of unsustainability" unless the said projects are coordinated and united by a number of common goals; in the present case, the goals of sustainable development that could be and should be achieved in Arctic. The key to the success of these supply-dependent projects is logistics, an expanded understanding of which is described below.

2. Extended interpretation of logistics as the research object
Traditionally, a couple of decades ago, many scholars and businesspeople in Russia considered logistics as managing transportation and storage (in Soviet times, the term “logistics” was not at all in use). A non-formal survey of Russian students and managers made by the authors [27] has shown that the big problem is that so many people in Russia do not actually understand what the logistics is. Till today, the subject field of logistics – in many textbooks – is often limited by transport and storage operations. However, an extended interpretation of logistics is now presented by scholars not only in their papers but also in textbooks. In many modern Russian textbooks, the logistics is defined as the science of organizing, planning, controlling and regulating the movement of material and information flows in space and time from their primary source to the final consumer. It is normal in the Era of Internet to do not forget about information flows and obligatory include them into the subject of logistics. However, the number of flows whose circulation should ensure the normal functioning of socio-economic systems is much wider. Bearing in mind the military origin of logistics, one cannot but include in the composition of the subject of logistics human flows and command/instruction flows (from marshals and generals to sergeants and soldiers); in business: working force (plus their families) and business instructions/orders/technology charts.

To get closer to the extended interpretation of logistics the marketing approach has been applied herein. Figuratively speaking, marketing and logistics have the same DNA – exchange – that defines the genetic proximity between marketing and logistics. In 1935 and 1948 the marketing was defined as “those business activities involved in the flow of goods and services from production to consumption” and “performance of business activities that direct the flow of goods and services from producers to consumers”, respectively [28, p. 140]. In turn, the American Council of Logistics Management defined (1991) logistics as “the process of planning, implementing and controlling the efficient, cost effective
flow and storage of raw materials, in-process inventory, finished goods and related information from point of origin to point of consumption (https://www.britannica.com/topic/Council-of-Logistics-Management). It is, to our mind, the quite sufficient reason why marketing concepts proposed and justified during previous decades could be used for conceptualizing logistics. Any marketing exchange is carried out as a joint and compatible movement of at least three flows: (1) information (offers, contracts and other supporting documents) material (products), (2) financial (cash and / or monetary obligations) and (3) products; moreover, all these flows can be bidirectional. The said flows are between manufacturer/seller side and buyer/consumer side – two opposite parties of any marketing exchange in the slightly simplified scheme of logistics. In real, it is necessary to include here logistics stakeholders; such as, carriers, banks, insurance companies, logistics service providers, warehouses, consulting companies, lawyers, and corresponding government agencies. It is possible to say that in the logistics management or management of logistics flows, the marketing component is responsible for the basic conditions for the movement of these flows (4P = product, price, place, promotion), and the said multidimensional component is responsible for the funds that must ensure the movement of the same flows (e.g. transportation, warehousing, inventory management, packaging, information and communication solutions). Factually, there is a reason to speak about interweaving marketing and logistics functions/operations where sometimes the marketing is seen as the main function that takes over logistics. This viewpoint reminds old (to our mind, fruitless) trials of logistics community to clarify relationship between logistics and supply chain management. Therefore, leaving the last question aside, we note that both marketing and logistics together facilitate the marketing exchange: speaking in short, the marketing mainly answers on questions WHAT [product], HOW [much does it cost], and WHERE [market place] while the logistics decides HOW [means of transport] and WHEN [time of delivery], and WHERE [point of delivery]. However, the above issues should be resolved only in conjunction, and the role of holistic intermediary and facilitator in the marketing exchange belongs to the appropriately arranged and completed set of logistics flows.

Therefore, the logistics is even not a cousin but a brother of the marketing due their similar DNAs and this fact permits using the “marketing approach” for applying the much more developed marketing theory to conceptualize the logistics. In our case, this makes it possible to use such universally recognized concepts as “marketing environment”, “marketing mix”, and “marketing ecology” [29, Ch. 3] to conceptualize logistics better and to get to understanding the logistics infrastructure in the context of sustainable development. The logistics environment is often represented – in connection with some of the LPI (logistics performance index) [30] components – in such interesting for our main topic dimensions as: (1) quality of transport-related infrastructure; (2) competence and quality of logistics services; (3) ability to track and trace consignments; and (4) frequency with which shipments reach the consignee within the scheduled or expected time. However, the above has been applied to the inner performance of logistics understood as an environment where material flows move as disaggregated shipments.

For our case we have to go out from this inner field of logistics. The outer logistics environment comprises of logistics stakeholders (interactions with) and the same uncontrollable marketing variables (impacts from and – for the case of the nature – impacts on). From the view of sustainability, it is necessary to “green” the inner logistics environment avoiding negative impacts on the nature and to take into account the outer logistics environment (nature dimensions included) to get to as best as possible logistic performance. The concept “logistics mix” is not so well known as “marketing mix”. Besides, in Russia, the semantic confusion takes place because the 7R-paradigm of logistics has been wrongly coined as a “logistics mix. While quite a while ago (1985) it was determined that the logistics mix comprises of such elements (functions/operations) as inventory management, warehousing, transportation, order processing and handling [31]. Logistics ecology is considered [32] as a bionic concept according to which the logistics environment understood as the basis and guarantee of realizing the logistics industry health, organic and sustainable development. And the said industry could be considered as the logistics infrastructure necessary for sustainable development of any regional socio-economic system. Therefore, before designing, constructing, and maintaining the logistics infrastructure in Arctic, the said infrastructure of sustainable development should be clarified and understood on theoretical level.
3. Understanding the logistics infrastructure in the context of sustainable development

First of all, it is necessary to return to correct understanding the term “sustainable infrastructure” and – due to the fact that the feature of sustainability is not the intrinsic and banal one for all contemporary social-economic infrastructures in the world – understanding the term “sustainable infrastructure development” [15]. Any infrastructure can be considered as a complementary factor for an economic growth that is a critical feature for any newly developed region, such as the Arctic, where energy availability factor remains perhaps the most important [33, 34]. As usual they say the infrastructure consists of large capital intensive natural monopolies such as highways, other transport facilities, water and sewer lines, and communications. Given the conventional understanding of the sense and scope of the term “infrastructure”, it should be said that there are only “spots of infrastructure” in the Russian Arctic and this “spots” are concentrated near settlements, sea/river ports and sites of extracting natural resources. Therefore, taking into account the extremely fragmented Arctic physical infrastructure the research/design focus should be targeted on communications – information and transport ones. The main goal of these communications is to integrate the socio-economic space of Arctic regions to provide opportunities to implement politics of sustainable development thereto. Infrastructure security and stability concerns the quantity of spare capacity which is a prerequisite for a proper functioning system. However, creating a spare capacity is a decision that involves the creation of a very extensive supply network where, in addition, the total length of the entire set of supply chains and, consequently, logistics transaction costs and risks, sharply increase. An alternative solution, in our opinion, can be found within the framework of the circular economy model [35] which involves using resources much more wisely: designing sustainable products that require fewer resources to make and use, that last longer and can be remanufactured once they are finished with.

A set of practices in transportation, packaging, and designing products could be used for achieving sustainability logistics [36]: (1) training drivers in eco-driving style, (2) using hybrid engines, (3) pooling of warehouses and transportation, (4) choosing multimodal transportation schemes (road, railway, fluvial, sea, and air arms) to reduce energy consumption, CO2 emissions and bottleneck traffics, (5) limiting packaging, (6) usage of double purpose and reusable packaging, and (7) increasing the rate of recyclability of specially eco-designed products. This brief listing of transport logistics solutions shows that their implementation takes place in the framework of the logistics infrastructure. However, before designing and constructing logistics infrastructure its concept should be got to. Defining logistics infrastructure by Russian scholars looks sometimes as too narrative and far from conceptualization (Table 1). However, in recent years, Russian scholars have begun move towards understanding the logistics as a three-part system (industrial, social, and institutional). This statement could be considered as a forerunner of holistic approach to defining the logistics infrastructure. Further development of the multidimensional representation of the concept “logistics infrastructure” has presented six components of the said infrastructure [37]: (1) institutional infrastructure; (2) social infrastructure; (3) research infrastructure; (4) regulatory infrastructure; (5) serving infrastructure; (6) technical infrastructure. We consider this representation as a good step toward the real conceptualization of logistics. The above should be enough to assert that the logistics infrastructure is a crucial condition for organizing direct and reverse logistics flows of any nature an in any region. The same should be said concerning an Arctic logistics infrastructure or, wider, logistics space [38] adjusted to achieving the goals of sustainable development.

Table 1. Structured content extracted from definitions of logistics in Russian textbooks (2001-2007)

| LOGISTICS ACTORS | LOGISTICS FUNCTIONS |
|------------------|---------------------|
| manufacturers of intermediate and finished products for B2B and B2C markets – carriers – railways and roads – loading and unloading terminals – warehouses – retailers – consumers – information units – communications | packaging – cargo handling – supplying materials and equipment – storage – inventory management – sales activities |

Source: developed by the authors
4. A holistic approach to creating a research model of new/upgraded logistics infrastructure

An appeal to foreign logistics literature revealed therein a very thorough analysis of the essence of infrastructure and its place in a market economy, corresponding to the pedantry of German economic school [39]. The conceptual three-part splitting of [socio-economic] infrastructures (material, institutional) was developed therein. Since, modern logistics infrastructure is inconceivable without its digital replica, the said replica has been included by us in the map of the holistic logistics infrastructure (Fig. 1). Without going into fairly obvious details, we note the interdependence of all four zones on the map of the logistics infrastructure, which is conveyed by a cross-shaped graphical symbol on the map of the logistics infrastructure, which is conveyed by a cross-shaped graphical symbol Fig 1.

Having performed a formal synthesis based on common and concise definitions of "logistics" and "infrastructure" we have: logistics infrastructure – a set of interconnected service structures/facilities that make up and provide the basis for managing material, information and human flows in order to minimize logistic transaction costs and risks. Taking into account, that most scholar works on sustainability logistics are concentrated on the reduction of environmental impacts of logistics operations [40] we suppose it is quite sufficient to insert in the definition of logistics infrastructure above such a contribution as at the same time with eliminating or minimizing any negative environmental impact of logistics. Thus an existing or predicted complex of different logistics flows and facilities should be taken as the starting point for modernizing or development of sustainable logistics infrastructure. First of all, it is necessary to organize the collection and systematization of requests for nature and the topology of direct and reverse logistics flows required for the sustainable development of the region in question. For this purpose, a conceptual framework of logistics infrastructure for implementing the circular economy model in the Russian Arctic has been developed and proposed herein (Fig. 2).
5. Conceptual framework of logistics infrastructure that could be used for the sustainable development of Russian Arctic

To monitor the sustainable development of the Arctic they have to collect a lot of not-so-well standardized data to form the environmental and socio-economic databases [2] acceptable for implementing the concept of sustainable development. The proposed holistic research framework for collecting and systemizing data on logistics flows in the Arctic and facilities necessary for constructing a sustainable logistics infrastructure is presented herein as the three-dimensional matrix [5x3x4] (Fig. 2). Its dimensions, respectively, are: (1) X - 5 environments for movement of logistic flows (underwater, water, land and underground, air and space ones) – note that the ground and underground layers are presented in this model together as “ground”; (2) Y – 3 temporal levels of existence, implementation and designing of a logistic infrastructure element (today - existing logistics flows; tomorrow - logistics flows on the way to be done; after tomorrow - planned logistics flows); (3) Z – 4 levels corresponding to the nature of logistic flows (material, informational, human and governing) – note that financing and settlements are included in the information flows. Thus, the authors consider the following algorithmic sequence of actions has to have a place for the initial stage of designing a sustainable logistics infrastructure:

1 – a need for a certain logistic flow (departure point and arrival point included) for a certain zone of the developed region is revealed/requested ⇒
2 – operating characteristics of the given logistics flow (for example, throughput, frequency of shipments, time of delivery, etc.) are determined
3 – the most suitable environment for the given flow is defined ⇒
4 – means of ensuring the movement of the given logistic flow (for example, vehicles, communication equipment, etc.) are determined ⇒
5 – business entities (actors) responsible for managing the given logistics flow are identified ⇒
6 – the given logistic flow is checked against sustainability criteria □.

The procedure above turns out to be multivariate and requires processing of large arrays of time-varying data, which requires to apply modern digital technologies (in particular, Big Data’s 4Vs class) [41]. There is a lot of achievements on the way towards creating digital decisions could be applied, being upgraded and adjusted, for development of sustainable logistics infrastructure in the Arctic [42-46]. We consider this holistic framework of sustainable logistics infrastructure only as conceptual one that...
should serve as the basis for creating a digital model in the future. Considering the application of the circular economy model for the implementation of the concept of sustainable development in the Arctic justified [47], we give some detail of this process in terms of building logistics infrastructure. Two drivers of sustainable development in the Arctic have to play a decisive role in implementing the model of circular economy therein – digitalization and using drones [27]. We add that in the case of the Russian Arctic, special institutions play an important role as conductors of state Arctic policy. Taking into account the said drivers the structural model of three-part digitized logistics infrastructure has been proposed (Fig. 3). The said model, in turn, is considered as an integral part of a prospective Siberia-Arctic digitized logistics megainfrastructure (Fig. 4).

Figure 3. Structural model of three-part digitized logistics infrastructure for the Arctic sustainable logistics infrastructure. Legend: S&H – software and hardware operating the sustainable logistics infrastructure; FPhl – facilities of physical infrastructure (aerospace units included). Source: developed by the authors

Figure 4. Conceptual model of a prospective Siberia-Arctic digitized logistics mega-infrastructure supported by Aerospace Systems. Legend: UAVs – unmanned aerial vehicles or logistics drones; AZRF – Arctic Zone of Russian Federation. Source: developed by the authors

The contemporary logistics infrastructure of the Russian Arctic (AZRF) is notable for its obvious fragmentation and underdevelopment, which causes many problems for its sustainable development. Among these problems could be noted: (1) underdeveloped infrastructure; (2) lack of large settlements and convenient logistics links between them; (3) severe and volatile weather conditions; (4) high costs of developing resources; (5) safety and comfort problems with arranging human presence; and (6) high degree of economic and social dependence on the rest of Russia (as they say “mainland”). With that said, a conceptual model of promising sustainable logistics infrastructure is proposed herein. This is a three-part digitalized logistics infrastructure with support for the aerospace grouping based on multi-altitude satellites, unmanned aerial vehicles (drones) and ground communications points (nodes). The latter (with the exception of military ones), at present, are concentrated mainly along the Northern Sea Route [3, 27]. The previous SWOT analysis of the prospects for the development of the Russian Arctic [27] has shown a number of weaknesses in the prospect of integrating logistics flows, both within the Russian Arctic, and between the Russian Arctic and the rest of the Russian Federation. A great contribution to these problems was made due to the so-called “post-Soviet hibernation” in the development of the Russian Arctic. The process of creating an integrated logistics infrastructure requires permanent monitoring and processing of very large data sets. Therefore, the conceptual framework presented herein is considered as could be of use in developing software that is necessary for collecting, sorting, and processing primary data. A draft of collection and initial expert estimations of data concerning logistics flows in the Russian Arctic and levels of their present and future digitalization is presented in Table 2. This table is factually a draft fragment of the map of logistics flows inside the air layer of 5-layer Arctic logistics infrastructure (one from designing five) with expert assessments of level of its existing-possible digitalization (DL) in the range 0 to 10. Due to the
limited number of interviews done with those who are skilled in the Art of developing the Russian Arctic the comments in the Table 2 are rather illustrative than predictive ones. Therefore, the authors consider the research results presented herein as the initial stage of a lot of work only.

6. Conclusion
The considerations and suggestions presented herein are mainly based on secondary data and represent a theoretical and conceptual study. Nevertheless, the following conclusions seem fairly reasonable to us: (1) further sustainable developing the Russian Arctic continues to be the crucial economical and geopolitical task for ensuring the sustainable development of Russia; (2) taking in account the specific vulnerability of the Arctic the best way for its sustainable development should be implementing the model of circular economy; (3) logistics continues to be a significant reserve, both to increase national competitiveness and to save resources or capitals of any nature (material, financial, human, and natural), that provides an additional and substantial reserve for the sustainable development of remote regions with undeveloped and fragmented infrastructure, which the Russian Arctic is; (4) the current insufficiently high level of conceptualization of logistics in Russia revealed requires the Russian scientific community to make further work in the field of methodology, partly in conceptualizing such a concept as “sustainable logistics infrastructure”; (5) the genetic kinship between marketing and logistics permits application of the marketing approach for increasing the level of conceptualization of logistics and should both accelerate relevant theoretical developments and avoid false theorizing; (6) similarly as in marketing the main and initial category is exchange, in logistics this place should be given to the flow, since namely the flow connect seller and buyer together mediating the exchange, that is conceptually important when designing logistics infrastructures; (7) in recent years, the concept of “logistics infrastructure” has received sufficient attention from Russian scholars, but requires further discussion (particularly considering the digital transformation of logistics and its greening) to develop conventional definitions and actually build a multi-level terminology paradigm of sustainable logistics infrastructure; (8) the procedure and architecture (three-dimensional matrix [5x3x4]) proposed for applying the research holistic framework for designing a network of logistics flows in the undeveloped regions look, in general, appropriate to the task of the initial design phase (a fragment of testing is shown in Table 3); (9) the said framework (after a number of refinements) could be considered a conceptual “starting point” for the development of a working digital model for designing a network of logistics flows in undeveloped regions as Russian Arctic is; (10) the theoretical and conceptual issues of logistics and supply chain management should occupy an important place in the syllabi for logistics managers, where, in our opinion, the concepts, tabular and graphic materials presented herein could find their place.

Table 2. Draft representation of the air layer in the sustainable logistics infrastructure of the Arctic

| CLF | LD | COMMENTS |
|-----|----|----------|
| AM1 | 1  | The outdated traditional Arctic aviation of Russia (airplanes and helicopters), inherited from Aeroflot Polar Aviation now continues to be used to transport people and cargo. Minimum digitalization (e.g. GPS/GLONASS and personal mobile devices). The initial stage of the introduction of unmanned air vehicles or drones (remote control). Digital remote control channels. |
| AM2 | 5  | The advanced stage of using drones even for people transportation (remote control and mainly automatic control). On-board computers serve not only for preliminary processing collected data but for flight control and emergency decision making. |
| AM3 | 10 | The air and amphibious drones are main fast, “green” (new powerful long life batteries), cost saving and flexible means of Arctic transportation, rescue operations, environmental monitoring. Drones’ on-board computers are capable not only to preliminary process collected data but to |
be involved as partial computers – when they form swarms of drones – in distributed computer and communication networks.

**AI1** 1 An obsolete traditional Arctic aviation (airplanes and helicopters) is supplied with analog voice channels. Still the most important communication "dispatcher-pilot" is an analog voice channel. The initial stage of the introduction of unmanned air vehicles or drones (remote control and automatic control). Digital remote control channels. On-board computers are used for preliminary processing collected data.

**AI2** 5 The advanced stage of using drones (remote control and mainly automatic control). On-board computers serve not only for preliminary processing collected data but for flight control and emergency decision making.

**AI3** 10 The highly developed stage of using drones (mainly automatic control) and drones virtually united into swarms for the exchange and distributed processing of digital data. Drones’ on-board computers (having features of artificial intelligence) are capable not only to process preliminary collected data but to be involved – when they form swarms of drones – in distributed computer and communication networks.

**AH1** 0 Traditional air people transportation. Digital devices in pockets of people.

**AH2** 5 Part of the air people transportation could be provided by UAVs. Digital channels of communications and navigation for manned aircrafts and remote control of passenger UAVs.

**AH3** 10 Much of the air people transportation is provided by UAVs. Digital systems are fully responsible for air traffic and flight safety.

**AG1** 0 Such cases are not revealed now.

**AG2** 5 Digital devices of drones could be used to transmit instructions from federal / regional / local authorities but only in the frame of aerial part of the intended extensive digital infrastructure of a single Arctic information space.

**Legend:** (for references see Fig. 1) – **CLF** – code of logistics flow; **LD** – estimated level of digitalization; **AZRF** – Arctic Zone of Russian Federation;

**Source:** developed by the authors

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