12 Adaptive Governance in Integrating Sustainability and Resilience into the Arctic Shipping Routes

The Kara Sea Case

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Introduction

Previous research on the interrelation between supply chain resilience and sustainability is relatively nascent and generally based on their mutual influences. Since there is still confusion about the terms and concepts, implementation methods, and measurements of resilient and sustainable supply chains, a recent study (Negri et al., 2021) critically examines major directions in the literature. Allegedly, supply chain resilience literature remains less mature, while there is general agreement on the theoretical foundation of sustainability. Besides, the nexus between two topics is highlighted as generally incoherent, and there is a major conflict, since resilience focuses on effectiveness, while sustainability often seeks efficiency (Negri et al., 2021).

As supply chain strategies are generally evaluated in terms of efficiency, profitability, and/or customer responsiveness, the sustainability of supply chains has also been attracting growing attention, due to globalization, increased competition, challenging markets, tighter regulations, customer pressures, and uncertainty in demands (Meixell and Luoma, 2015; Ansari and Kant, 2017). In addition to shortened product life cycles, greater demand volatility, and growing innovation rates, these recent trends have negatively affected supply chain vulnerability (Negri et al., 2021; Christopher, 2011; Christopher and Peck, 2004a). Therefore, there is a need to examine supply chain resilience in terms of preparing for, resisting, and recovering from disruptions; accordingly, the growing Arctic economic activities and their associated risks to its

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unique environment have necessitated a different point of view (Nakano and Akikawa, 2014; Tsvetkova and Gammelgaard, 2018).

Enhancing the resilience in the Arctic has become essential, as the Arctic Region has increasingly been experiencing the detrimental impacts of human-induced climate change. During the Swedish Chairmanship of the Arctic Council (2011–2013), in line with the necessity of establishing a common ground for the unification of resilience efforts, the resilience concept was emphasized as a priority, and the Arctic Resilience Action Framework (ARAF) was developed in May 2017. However, it has also been pointed out that this is a tough process, since there are “many Arctics”. The sparse population and remoteness of the Canadian Arctic, the interconnected regions and relatively high population of the Nordic Arctic, as well as the combination of densely and sparsely populated regions of the Russian Arctic, indicate a multilateral Arctic setting (Josephson, 2014; Sergunin and Konyshev, 2015).

Accordingly, in recent years, amid the sustainability and resilience concerns, growing numbers of commercial maritime activities on the high seas are currently threatening both the resilience and sustainability of the region. On the one hand, the rapid melting and receding of the sea ice stimulates exploration and the exploitation of natural resources, as well as an accelerated expansion within maritime activities. On the other hand, environmental concerns related to oil pollution, marine mammal displacement, the “Atlantification” process and carbon emissions have sparked a global interest in the fundamental changes shaping and compelling legal, regulatory, and capacity-building of shipping and supply chain operations in the region (Gross, 2018; Pedro and Fraser, 2018; Downing, 2019).

Moreover, responding to a situation in a safe and timely manner within a spatially extensive region entails a comprehensive governance framework due to the considerable uncertainty and constraints. Therefore, building resilience in the Arctic shipping routes can be achieved by implementing an adaptive governance model in which sufficient national and international input can be provided by means of key actors. As a relatively new form of environmental governance, adaptive governance can be explained as a model developed to coordinate resource management while addressing the uncertainty and the complexity of environmental change (Folke et al., 2005). Further, how legal and institutional barriers would be overcome while bridges are being built from current governance structures represents a significant challenge. Therefore, focusing on the institutionalization process of adaptive governance in relation to legal and institutional barriers within the Arctic would contribute to the knowledge gap.

This study aims to investigate how supply chain resilience is built within the temporal and spatial variations in shipping in the Russian Arctic. Based on the knowledge gap, the importance of integrating resilience and sustainability into the Arctic shipping routes is also emphasized. It is constructed as a single case study based on the Kara Sea, and the data are taken from the NSR Administration and the Centre for High North Logistics (CHNL). The case is analyzed by adopting exploratory narrative processing, and the data for the case description are extracted from a range of different documents including the NSR Administration and CHNL websites (between the years of 2012 and 2019)[1], government statements, related legal documents, and press releases. Our case study analysis is based on the temporal and spatial variations and how melting and retreating variations in sea ice affect shipping activities (Duan et al., 2019). The names of shipping companies are mentioned since the main data of our case study are based on the variations in shipping activities, and internet sources are investigated to outline the nature of these activities.

After a brief introduction of the term "supply chain resilience", the theoretical framework of adaptive governance is discussed. An overview of shipping activities in the Russian Arctic is given to illustrate the background of supply chains within the region. Since the Kara Sea is selected as the case, temporal and spatial variations in shipping in the Kara Sea are examined in detail. Following the discussion of governance challenges regarding the Russian Arctic, we present the way in which supply chain resilience, in terms of sustainability, is built within the temporal and spatial variations in shipping. Consequently, our chapter concludes with significant insights from our case study about the potential for integrating resilience and sustainability into the Arctic shipping routes.

Resilience within Sustainable Supply Chains: Literature Review

A supply chain can be defined as

> *the network of companies involved in the upstream and downstream flows of products, services, finances, and information from the initial supplier to the ultimate customer.*
>
> *(Mentzer et al., 2001; Lambert et al., 2005)*

In supply chain operations, the quality and reliability of the transport bring interdependent organizations together through binding instruments transcending national borders, as well as extending the coordination capability of a single organization. Since both resilience and sustainability are critical terms for supply chains, Ahi and Searcy (2013) suggest improving sustainability performance along the triple bottom line, while it is also necessary to address increasing uncertainty and vulnerability in supply chains (Ali et al., 2017). There are studies that investigate the impact of sustainability and resilience on organizational performance and supply chains, which claim that integrating sustainability into business operations can improve performance, and resilience can be perceived as a source of competitive advantage (Pinto, 2020; Klibi et al., 2010). Besides, there is also empirical evidence stating that resilience and sustainability influence each other (Fahimnia et al., 2019). Resilience can be defined as

> *the capacity of communities and systems to recover and restore themselves from various kinds of crises and disturbances.*
>
> *(The Arctic Council Secretariat, 2021)*

On the other hand, supply chains are complex networks of organizations experiencing continual turbulence, which may lead to unpredictable disruptions. Factors that contribute to disruptions in supply chains are listed as: "global supply chains", "increased volatility of demand", "specialized factories", "technological innovations", "centralized distribution", "reduced supplier base", and "increased outsourcing" (Pettit et al., 2010, p. 2). The integration of resilience and sustainability within a supply chain context remains an underexplored field since the research streams of both terms have been investigated separately in the literature. In order to facilitate the implementation of resilient and sustainable supply chains, at the nexus of resiliency and sustainability, a sustainable supply chain is defined as

> *the creation of coordinated supply chains through the voluntary integration of economic, environmental, and social considerations with key inter-organizational business systems designed to efficiently and effectively manage the material, information, and capital flows associated with the procurement, production, and distribution of products or services in order to meet stakeholder requirements and improve the profitability, competitiveness, and resilience of the organization over the short- and long-term.*
>
> *(Ahi and Searcy, 2013)*

Moreover, traditional methods for risk management tend to lack the competence to assess the complexities of supply chains and comprehend the intricate types of threats (Starr et al., 2003). Based on empirical research, an initial framework for a resilient supply chain has been developed. According to that research, resilience can be achieved through four key principles:

1. Rebuilding through recovering from disruptions within the chain
2. Identifying and managing risks through a high level of collaboration
3. Agility to respond to unpredicted events on time
4. Implementing a risk management culture (Christopher and Peck, 2004b).

The extant literature provides 16 definitions for the term "sustainable supply chain management", most of which focus on the economic and environmental dimensions, but the identification and testing of the impacts related to culture, geography, and company size are missing. In order to bridge the gap, a new term for supply chain management was introduced, titled "World Class Sustainable Supply Chain Management". The new term underlines the development of a suitable organizational culture, increasing awareness, the use of new and innovative technologies, the involvement of top managers and employees, as well as society, while considering the adverse effects of the aforementioned practices on the environment, social equity, welfare, and ethical values (Dubey et al., 2017).

In recent years, exploration and exploitation of natural resources have renewed the interest in the reliability of supply chains within the Arctic. Increasing commercial maritime activities have spurred a number of concerns that are grouped under three headlines. The first headline consists of climatological changes, including the social and environmental consequences of enlarging supply chains (Meschtyb et al., 2005; Fan et al., 2018). The second headline deals with the economic dimension of the shipping routes, including the commercial potential of containers, liquid and bulk cargo, as well as fishery routes (Verny and Grigentin, 2009; Gudmestad and Bai, 2020). The last headline focuses on the scientific data, including satellite coverage, sea ice prediction, and navigation, in order to enhance ship construction, navigational aids, and ice classification (Stephenson et al., 2013; Pelaudeix and Basse, 2018). Concordantly, environmental changes closely embody the general framework in which supply chains have become more complex and vulnerable. Therefore, applying a network perspective is suggested, in order to address the complexities while ensuring a safe environment (Taarup-Esbensen and Gudmestad, 2022).

However, supply chain operations are highly complicated endeavors founded on command, coordination, and control structures between the Arctic states, as well as internal applications (Andreassen et al., 2019). In addition to remoteness and lack of sufficient infrastructure, frequent harsh weather and limited navigational information generate challenges during supply chain operations. While supply chain management traditionally concentrates on creating systems in which implementing suitable technology ensures the reliable and timely transfer of goods, the effects of climate change, especially on sea ice, have transformed the Arctic into a more accessible region. On the other hand, in addition to similar risks in other areas, the Arctic context presents unique hazards, grouped under four themes: safety, environmental, technical, and reputational (Afenyo et al., 2020; Smits et al., 2017). In order to develop safe, resilient, and sustainable maritime transport in the Arctic, a number of recommendations are presented in the previous body of literature (Brigham, 2011; PEW Charitable Trusts, 2016; Carter et al., 2017). Accordingly, managing supply chain hazards in the region concentrates on two essential parameters which will improve reliability and ensure greater integrity. The first parameter focuses on establishing the right balance between effective management and implementing new technology. In this case, if one connection fails, alternative ways safeguard its integrity, thereby ensuring the resilience of the overall system. The second parameter includes protective barriers that initiate improvements in emergency response coordination, enhancing business recovery, and icebreaker assistance (Taarup-Esbensen and Gudmestad, 2022).

Adaptive Governance: Theoretical Framework

Governance and its implications have different meanings in scientific and political contexts (Kooiman, 2003). In this chapter, these two contexts are combined, and the term can be defined as

> *the structures and processes by which people in societies make decisions and share power, creating the conditions for ordered rule and collective action, or institutions of social coordination.*
>
> *(Schultz et al., 2015, p. 7369)*

Since the traditional top-down and centralized governance systems fail to address ecological complexity, which is further complicated by rapid environmental change, a growing number of bottom-up governance systems have emerged, including social networks, local actors, and community leaders (Brosius et al., 2005). However, despite their effectiveness at a local scale, these types of governance systems also suffer from various problems, particularly based on coordination across complex geographies (Cosens et al., 2014). Besides, there have been serious discussions regarding their inclusiveness, especially in terms of indigenous communities (Bark et al., 2012). Hence, there is an urgent need for a new approach to confronting landscape-scale problems that is flexible enough to deal with highly contextualized socio-ecological systems, while being responsive and dynamic enough to adjust to unpredictable and complex feedback between the components of the related system.

Adaptive governance is a relatively new form of environmental governance, developed to coordinate resource management while addressing the uncertainty and the complexity of environmental change (Folke et al., 2005). There is a growing number of studies suggesting that better resilience can be achieved through implementing adequate adaptive governance (Huitema et al., 2009; Mathijs and Wauters, 2020; Feindt et al., 2019). Environmental governance systems are forced to be adaptive due to the uncertainties caused by global environmental change and the risks associated with climate change. Different points of view regarding the implementation of mandatory targets and timetables to deal with greenhouse gas emissions have also highlighted the significance of adaptive systems (Brunner and Lynch, 2010; Chaffin et al., 2014). Accordingly, adaptive governance literature mainly focuses on resilience, environmental governance, and socio-ecological systems (Cumming et al., 2006). Therefore, adaptive governance offers a flexible framework to address environment-associated risks, develop policies to deal with the unavoidable effects of climate change, and assist mitigation processes (Brunner et al., 2005).

In terms of the Arctic case, climate change is highlighted as the most significant stressor due to its detrimental effects on sea ice, which in turn have essential implications for both wildlife and human populations in the region (Arctic Council Secretariat, 2021; CAFF, 2013). Aside from climate change, other key stressors are presented as pollution and the growing number of economic activities, such as oil and gas development, shipping, tourism, and commercial fishing (Stepien et al., 2016). Since adaptive governance connects institutions and actors (individuals, agencies, and organizations) at multiple organizational levels, it may provide a common ground for unifying the concerns about resilience in relation to sustainability within the Arctic supply chains, in particular shipping and safety. Key actors assume leadership, elicit a vision, and build trust in this governance model. Then, a transformation toward a learning environment can be initiated, by drawing on experiences related to a common understanding and development of policies and various knowledge systems. Therefore, the adaptive governance model frequently self-organizes social networks with the actors in an inclusive manner (Folke et al., 2005). Besides, key actors operate through established norms, and institutional theory deals with the construction of the aforementioned norms. Institutional theory is based on the more resilient aspects of social structure, including rules, norms, and routines as authoritative guidelines (DiMaggio and Powell, 2000). Accordingly, the institutional perspective would enable a unique approach to understanding the economic, social, and political dynamics within the Arctic. As a dynamic region threatened by the associated risks of climate change, the Arctic setting has necessitated an effective adaptive governance framework in which resilient arrangements are ensured, to be able to adapt to the evolving demands for governance through time, without compromising the ability to address both existing and emerging problems (Young, 2015).

An Overview of Shipping in the Russian Arctic

In the Arctic Region, consistent and accurate data on maritime activities are essential to foresee safety conditions, develop infrastructure, plan safe shipping routes, monitor environmental and cultural impacts, as well as manage protected areas, taking sovereignty rights into consideration. However, the limited availability of longitudinal and consistent data sources, including temporally and spatially accurate maritime activities, has presented significant challenges for policymakers, planners, and researchers. Accordingly, geospatial databases of ship traffic have recently been developed to address the aforementioned challenges (Dawson et al., 2017).

Although there are three major maritime connections within the Arctic waters – the Northwest Passage (NWP), the Northeast Passage (NEP), and the Trans-Polar Passage (TPP) – there has been a significant difference in terms of commercial usage due to the harsh conditions and low level of accessibility of the NWP and TPP. Accordingly, the NEP is considered the most accessible Arctic shipping route in terms of navigational conditions (Stephenson et al., 2013). The NEP also includes the Northern Sea Route (NSR), a term which is sometimes used interchangeably with the NEP, due to its frequent commercial shipping traffic.

The NSR extends all the way to the Bering Strait, passing through the Kara Sea, the Laptev Sea, the East Siberian Sea, and the Chucki Sea (Peresypkin and Yakovlev, 2008). The route was envisioned to be 25–45% shorter in the case of regular shipping becoming possible between Eastern Asia and Western Europe. Concordantly, the NSR consists of different variants of shipping routes, ranging from shallow coastal routes to routes with a deeper draught, which also affect its length, from 2,200 to 3,000 nautical miles. Russia (formerly the USSR) has used the NSR as a shipping route for the regular delivery of fuel, goods, supplies, as well as raw materials such as timber and coal to remote settlements since the early 1930s (Østreng, 1999). Known as "northern deliveries", this type of transport occurred during the late summer depending on the sea ice conditions and involved Russian inland waterways. The official opening of the NSR to international shipping dates back to January 1991. The International Northern Sea Route Programme (INSROP), comprising more than 450 researchers from 14 states, was developed between 1993 and 1996 by Russia, in order to explore the availability of the extended use of the NSR (Ragner, 2010). In connection with INSROP, the first commercial international transit of modern times was conducted from Yokohama to Kirkenes in 1995. International transit voyages were hindered due to unprecedented changes in sea ice cover in the following years until 2007. Drastic reductions in sea ice coverage in 2007 have renewed international interest in the NSR. The Arctic Shipping Assessment by the Arctic Council in 2009 is especially significant, since it is the first official document consisting of several shipping scenarios in relation to sea ice conditions, with a specific focus on enhancing marine safety, as well as environmental protection, in the Arctic (AMSA, 2009).

In the period up to 2019, international shipping companies from several states conducted voyages via the NSR. However, as the current phase of shipping on the NSR is dominated by the transport of hydrocarbons, international transit seems to have become less central, contrary to Russia's expectations. Furthermore, the NSR was highlighted as less attractive due to the global economic turndown, reduced bunker fuel prices, declining demand for raw materials, and depressed freight rates in 2014. The Ukraine crisis and the EU and U.S. economic sanctions have further discouraged international shipping companies from involvement in long-term investments in the NSR ventures. Despite Atomflot's heavy promotion, cargo owners and shipping companies remained cautious, and, although the number of international transits increased between 2016 and 2019, this was not reflected in cargo volume (Gunnarsson and Moe, 2021).

Apart from promising future projections pertaining to the NSR, Russia cannot determine the volume of international traffic, and it is not possible to reach its aim to boost annual transit volumes to 30 million tons in 2030 (calculated as 1.3 million tons in 2020), without offering sufficient infrastructure. Accordingly, large-scale investments are planned, especially in the pipelines in which Rosatom will undertake the major role in order to ensure all-year-round navigation in the NSR. Since the international shipping industry determines the balance of factors and conditions, Russia has recently stated that new legislation, in which Russia's obligations are harmonized with international law, will be adopted (Staalesen, 2021).

Moreover, in 2017, China and Russia reached an agreement to create an "Ice Silk Road" (Xinhua, 2017). Being the only Chinese company, COSCO Shipping successfully carried out 22 Arctic voyages between 2013 and 2018. Besides, China has proceeded with major investments in the Arctic oil and gas industry of Russia, especially the megaproject of Yamal by NOVATEK (Humpert, 2019). Other states also have similar agendas concerning the NSR. It is also expected that the international shipping industry will determine whether the NSR is safe, efficient, reliable, environmentally sound, and economically viable in comparison with other routes.

Temporal and Spatial Variations in Maritime Activities in the Kara Sea

There have been several studies examining the shipping traffic along the NEP and the NWP, both comparatively and separately (Østreng, 2012; Lu et al., 2014; Lasserre and Alexeeva, 2015; Li et al., 2020, PAME, 2021). Temporal and spatial variations can be explained as how melting and retreating variations in sea ice affect shipping activities (Duan et al., 2019). While the most severe ice conditions were encountered between the Laptev Sea and the Kara Sea 30 years ago, the ice-free season increased by 82 days in the eastern part of the Kara Sea and by 65 days in Kara Gates in 2012 (Rodrigues, 2009). Besides, it is expected that old ice cover reduction will be the most rapid in the same region (Pastusiak, 2016).

In a recent study, in which spatial and temporal shipping variations in 10 ship types (tanker, general cargo, icebreaker, bulk carrier, fishing vessel, heavy lift, research and survey vessel, tug, and dredger) are separately investigated, Li and Otsuka (2019) found that shipping activity related to all ship types presents a clear spatial and seasonal variation in the Kara Sea (specifically in the southwestern part from July to October). In the same study, shipping activity mainly occurred in the Kara Sea, including most ship types. General cargo, bulk cargo, and tankers are found to be the dominant types, while the Chukchi Sea stands out for passenger ships, in terms of spatial variation. There has been a gradual increase in the number of sailed ships (especially large ships) from 2013 to 2017. Since supply chain development within the Kara Sea is primarily associated with maritime transportation (frequent supply chain vessels in the Arctic region are noted as transiting container ships, tankers, and bulk carriers) (Eguiluz et al., 2016), these numbers indicate a steady increase, accordingly.

As argued by Li et al. (2020), the main drivers for maritime traffic in the NSR are essential natural resource developments in the Kara Sea (crude oil, natural gas, hard minerals of copper, nickel, and palladium), particularly in the

Western Water Area. Since the NSR activities mainly take place in the Kara Sea water area to Sabetta, our study also focuses on the Kara Sea. When the statistics on shipping in the Kara Sea between 2013 and 2018 are examined from a closer perspective, it is found that voyages to Sabetta, Dudinka, and Novy Port are predominant compared to those to Dikson and other ports.

It is noteworthy that, in the warm season (from July to October), both ship numbers and mean deadweight tonnage (DWT) are relatively high, and there has been an increase in the amount of annual DWT to Sabetta (with the exception of 2017). DWT is mainly carried by dry cargo ships from Europe and the Pacific; oil tankers, mainly from European ports and Murmansk; and LNG carriers, generally from Europe, with minor amounts from the Pacific. Furthermore, most of the DWT was carried from Europe to Novy Port by oil tankers. The main reason behind the increase in tanker shipping activity was stated to be crude oil transport, and shipping activity increased mainly in the south-western region of the Kara Sea (Li and Otsuka, 2019).

In the case of Dudinka Port, which is the industrial complex located in Norilsk, the DWT is mainly carried by cargo ships from Europe and Sabetta, with some carried by oil tankers from Europe (mainly), Sabetta (partly), and less from other water areas. Taarup-Esbensen and Gudmestad (2022) assert that the tripling of ship traffic in the Arctic between 1990 and 2015 is a challenge to choose suitable preventive and protective barriers, which will ensure reliability and improve supply chain resilience. Since the resilience of supply chains depends, in the Arctic case, on investments in port facilities, ice class ship designs, and communication installations, they further investigate the effective coordination of organizational resources to properly manage protective barriers.

Furthermore, since the early 2000s, river tankers have been delivering crude oil to terminals in the Kara and Laptev Seas by the Lena and Ob Rivers. Yenisey River is another significant location due to the Dudinka Sea and River Port being used as the main transport facility by Norilsk Nickel; gas condensate is frequently exported via the NSR and the Barents Sea. In Ob Bay, Gazprom Neft managed to conduct the first winter oil-offloading operation in 2015. In the long term, it is expected that the huge Kara Sea and Yamal oil/gas resources will be transported to the Asian and European markets, since the South Kara Sea is rich in hydrocarbon resources, as well as undiscovered gas (estimated 1.64 billion tonnes of gas and oil and 26.5 trillion cubic meters of natural gas) in the Arctic (Bambulyak et al., 2015), as a driving force for prospective industrial development. Therefore, Russia's future gas production is closely linked to the Kara Sea and the Yamal Peninsula.

Accordingly, in addition to the existing Gazprom–TotalEnergies alliance, Rosneft has also started to explore the continental shelf, in alliance with ExxonMobil. Moreover, Novatek is proceeding to cooperate with TotalEnergies and China National Petroleum Corporation on the Yamal LNG Project (TotalEnergies, 2021). The construction, in 2009, of a 560-kilometer-long pipeline, connecting Vankor–Purpe with the Transneft trunkline system, as an extension of the Tagulskoye field development, has enabled the exportation of crude oil from Vankor eastward. The main objective of the project is to establish the Vankor cluster as a major hub for oil production. The Tagulskoye field development is further nourished by oil transport via the Vankor–Purpe pipeline, power supply, and gas monetization arrangements supplied via the Vankor field to Gasprom's infrastructure (Rosneft, 2017). The establishment, in 2012, of the Independent Petroleum Company (to explore and produce oil and gas) has further highlighted the significance of the Yenisey River (Bambulyak et al., 2015).

Moreover, spatial effects of the projects within the region rely on both existing and planned Arctic projects, particularly in Yamal-Nenets Autonomous Okrug. In addition to Yamal LNG and the development of the Novoportovskoye, Bovanenkovo, and Yaro-Yakhinskoye fields in Yamal-Nenets, the group of Messoyakha deposits indicates a rising trend in spatial effects. Moreover, Arctic LNG-2 and the planned development of both the Lavayozhskoe and Vaneyvisskoe would assist the rising trend (Pilyasov and Putilova, 2020).

Possessing the second longest railway network after the United States, Russia also has 933,000 kilometers of roads in total (Federal Statistics, 2010). According to Federal Statistics (2010), railways undertook 42.7% of the total freight turnover. When pipelines are excluded, the turnover increases to 85.2%. Therefore, in order to develop the hinterland, improve accessibility, and benefit from its road and railway infrastructure, the Government of Russia (2008) announced the "Strategy for the Development of Railway Transport in the Russian Federation Until 2030". In order to enhance freight transportation via railways, a number of priorities are determined: railway engineering modernization, transport infrastructure improvement, improving and ensuring the safety and quality of freight transportation, transport cost reduction, achieving mobility, and boosting the country's transit potential. Furthermore, approval of the long-term railway development program until 2025 and the renewal of the locomotive fleet, as well as increasing the volume of transportation of both the Trans-Siberian and the Baikal-Amur railways, have become concrete steps to enhance the resilience of supply chains. In addition to existing railway projects, the revival of the Northern Latitudinal Passage (NLP), including a railway connecting industrial settlements of the region to the Kara Sea, is another key development to improve the resilience of the supply chain networks.

The railways are expected to transport at least 9 million tons of goods and implement a new export route to carry natural resources from Yamal via the NSR. The NLP consists of two parts: an east–west connection extending to the Ob, which connects the line between Tyumen and Nadym, as well as the Northern Line from Arkhangelsk. The other part extends 170 kilometers through Bovanenkovo (using Gasprom's current railway) to Sabetta (Staalesen, 2021). Therefore, in addition to a railway junction, linked with the Polar Road including the Nadym–Salekhard region, the planned railway would link two essential railway lines within the Russian Arctic.

Since the existing road and railway networks have proved to be insufficient in the Russian Arctic, the development of transport infrastructure (shipping, road, and railway networks) has a high potential to maximize the NSR and its associated supply chain networks' capacities (Elyakova et al., 2019; Zamyatina and Pilyasov, 2018; Buixade et al., 2014). While the Trans-Siberian Railway remains vital, owing to its vast transit capabilities, a new large-scale project, called "Siberian Meridian", was proposed in 2019. Including the Northern Latitudinal Railway (NLR) will provide cargo railway connection between the ports of the NSR and China, covering large parts of Siberia by 2035. If the project is implemented, a ring railway, Salekhard-Nadym-Urengoy-Surgut-Tyumen-Yekaterinburg-Perm-Yaroslavl-Ob-Salekhard, will be constructed (Chirkova, 2016).

Developing infrastructure in the coastal region of the Kara Sea and building an atomic icebreaking fleet have long been among the priorities of the Russian government (Moe and Brigham, 2017). Implementation of the North–South axial Northern Corridor, which connects the Asian states (Uzbekistan, Kazakhstan, Kyrgyzstan, and Tajikistan) to the Kara Sea, will further boost the economic development within the region, as a major economic vector for Central Asian economies. Herein, Sabetta port becomes prominent as a multi-functional trade terminal, as it is the essential gateway of the NSR to Asia, America, and Europe for all Russian territories (Yvarova, 2019; Sibileva and Kontorusova, 2020). In addition, a decree was signed to construct new infrastructure, including the new Sever Port as a key logistical hub at the southwest of Dikson (Staalesen, 2020). Since the project contains a 770-kilometer oil pipeline and about 100 drilling rigs, it is envisioned that infrastructure within the Taymyr region will be improved. Besides, Rosneft initiated a major research expedition in the northern part of the Kara Sea in 2020, drilled the first geological wells in the Laptev Sea to collect core samples, and revealed its stratigraphic drill plans for 2022 in the Chukchi Sea (Rosneft, 2021). Furthermore, it is even anticipated that the Novaya Zemlya archipelago can be used as a cluster base. In this case, the whole region of the western Kara Sea and the eastern Barents would be developed, as long as a "unitization principle" is implemented to improve field development. In line with that point of view, the building of an LNG plant, a port for LNG tankers, and a pipeline system is proposed (Efimov et al., 2014).

Governance Challenges of the Arctic Shipping Routes

Emerging economic opportunities in the Arctic are expected primarily within two main domains: the opening of shipping routes and the growing access to natural resources empowered through technological advancements (Moe and Brigham, 2017). Both domains are inherently linked with the use of fossil fuels, production, and transportation. Since tanker traffic, offshore drilling, and other maritime activities tend to increase, the risk of accidents and oil pollution is also expected to threaten the sustainability of the region.

On the other hand, improvement in infrastructure facilitates connection, access, productivity, and inhabitation, therefore enabling human engagement. Since infrastructure is the key to the facilitation of supply chain operations in the Arctic, how sustainable infrastructural development will be ensured and the integration of resilience, accordingly, will become significant discussion matters (Malindretos and Binioris, 2014).

The exceptionally low extent of the sea ice in the Arctic Ocean, firstly in September 2007 and subsequently in 2012, have stimulated major discussions, ranging from environmental protection to emerging economic opportunities based on navigation. The reduction in the thickness and extent of ice cover has shown a tendency to accelerate, and even vessels without ice strengthening are able to navigate during the summer season. In a recent study, the available knowledge and predictions related to the NSR are systematized from a scientific point of view, including environmental and technical conditions, as well as hydrological and climatic conditions (based on IPCC models) (Pastusiak, 2016). It is found that an increasing amount of shipping has accompanied the development of fossil fuel extraction in the Kara Sea and the Yamal Peninsula, which overlaps with the findings of another study by Peresypkin and Yakovlev (2008).

Above all, there have been more than 500 maritime accidents reported in the Arctic over the last decade. In order to enhance navigation safety "for ships operating in polar waters" and mitigate the associated risks of Arctic shipping, the Polar Code was put into effect in January 2017 by the International Maritime Organization (IMO). A decision tool, titled the Polar Operational Limit Assessment Risk Indexing System (POLARIS) was developed through risk classification and proceduralization by the IMO (Fedi et al., 2018).

However, a recent study has highlighted the reasons why both the Polar Code and POLARIS are currently insufficient to govern the risks associated with Arctic shipping as a holistic framework. Although both the Polar Code and POLARIS constitute a significant decision support tool, as well as a suitable mitigation response related to ice risk, the officers' skills and experience and the capacity of the vessels are also underlined as vital, since there have also been accidents while sailing in safe areas, as in the cases of the *Inger* (general cargo ship) accident in 2006 and the *Chukotka* + (tanker) delay in 2017 (Fedi et al., 2020).

Supply Chain Resilience in Terms of Sustainability in the Kara Sea Region

In recent years, Arctic shipping has been evolving at a rapid pace, owing to the emerging opportunities for resource extraction, fishing, and tourism, as well as the needs of government agencies and communities, reflected in shipping patterns. The regulatory mechanisms have been updating provisions in line with the changing environmental conditions (Dawson et al., 2014, 2016; Porta et al., 2017). In terms of supply chain, although cooperation with the Russian Railways was generally pointed to as positive, a number of problems were also indicated. Herein, the lack of cooperation among supply chain partners was particularly highlighted, and intermodality was found to be troublesome (Laisi, 2010).

Firstly, the evolution of the traffic patterns in the Arctic and the long-term trends are highlighted as vital to define the needs for oil spill response, identify places of refuge, and plan for protected areas. Furthermore, the related data can be useful for researchers studying marine mammals (and the relationship between environmental and human impacts), significant cultural and ecological sites, and Arctic bird species. Therefore, establishing a comprehensive and longitudinal framework of each route's maritime traffic and its variability, based on overall activity, temporal and spatial distribution, vessel type, and proximity to communities, is essential in terms of addressing the challenges and ensuring good governance (Dawson et al., 2017; Pizzolato et al., 2016; Eguiluz et al., 2016).

Since the Arctic regions are diverse, a more comprehensive governance framework is needed to simultaneously enable strategic infrastructure development, ensure a solid foundation for policy decisions, and protect the environment. When the case of the Kara Sea is examined from an institutional perspective, in addition to public organizations Rosatom and Novatek, major investors, such as Northern Shipping Company and Sakhalin Shipping Company, alongside Chinese COSCO, stand as key actors, while the Polar Code and POLARIS are the prominent institutions regulating the shipping activities in the territory. In order to conduct shipping activities in polar waters, vessels are required to hold the Polar Water Operational Manual (PWOM) and the Polar Ship Certificate (PSC). Moreover, the Russian government is particularly strict with its regulation (Tsvetkova, 2020).

Although the development of Arctic maritime supply chains necessitates a crucial balance between environmental protection, economic growth, and social relations, the existing projects are often recognized by single-criterion decision-making to the detriment of other components. Therefore, the existing institutions are criticized due to the neglect of certain factors such as the issue of the non-compliance or crew experience of international vessels (Fedi et al., 2020). Besides, the residents of the Arctic have also become key actors since they are directly affected by the supply chain activities within the region. That is why international investors and financial institutions have developed guidelines and standards to protect Indigenous People's rights, in terms of traditional natural resource use, development plans for these communities, and sharing benefits in the form of social investment. However, Russian companies remain less sensitive to the transnational stakeholders' opinions, since the level of state ownership is relatively high, and many countries are dependent on Russian oil exports (Rodgers, 2015; Wilson, 2012).

Conclusion

The limited availability of longitudinal and consistent data sources, including temporally and spatially accurate maritime activities, presents significant challenges for policymakers, key stakeholders, and researchers. Based on our case analysis, we found that there has been a significant increase in shipping traffic in the NSR, and the voyages have been mainly conducted in the Kara Sea by LNG carriers, oil tankers, and dry cargo ships, which account for 82.55% of total DWT along the NSR between 2013 and 2018.

When our findings are examined from an institutional perspective, in addition to public organizations, Rosatom and Novatek, major investors, such as Northern Shipping Company and Sakhalin Shipping Company, alongside Chinese COSCO, stand as key actors. The Polar Code and POLARIS are the prominent institutions regulating the shipping activities in the territory, while the Russian government is particularly strict with its regulation. Since the resilience of supply chains depends, in the Arctic case, on investments in port facilities, ice-class ship designs, and communication installations, the effective coordination of organizational resources to properly manage protective barriers is essential. Accordingly, a more comprehensive governance framework is needed, in which infrastructure investment, including ports, navigational aids, icebreakers, environmental response, and enhanced search and rescue activities, as well as research into ice conditions (ice thickness and ice ridging), are managed in an effective manner. Considering the diversity of the actors, developing an adaptive and inclusive governance model, in which sufficient national and international input can be provided by means of key actors, holds the potential for the unification of resilience efforts. Furthermore, developing an adaptive governance model is also important for ensuring the sustainability of supply chains, since managing supply chain challenges in the region concentrates on two essential parameters. While the first parameter focuses on establishing the right balance between effective management and implementing new technology, the second parameter highlights protective barriers that initiate improvements in emergency response coordination, enhancing business recovery, and icebreaker assistance.

To conclude, by eliminating the gaps within the human factors (such as the lack of international crew experience), strengthening the Polar Code and its applications, not only in the Kara Sea but also throughout the entire Arctic Ocean, is highly significant. Moreover, it is also necessary to go beyond single-criterion decision-making in major projects. The potential decline of cargoes along the NSR due to sanctions would cost up to \$1.7 million, which would directly affect supply chain operations negatively within the Kara Sea region. Besides, recent sanctions have hindered supply chain resilience and sustainability. Given the complexity of the interrelation between sustainability and resilience, developing analytical decision-support tools is recommended for decision-makers to evaluate resilient and sustainable supply chain solutions

(Fiksel, 2006). Therefore, in addition to ensuring technological integration, by taking the Polar Index into consideration (including all the types of impact factors of an efficient sustainable development process), developing a new and adaptive governance framework is recommended, to enhance resilience in the Kara Sea.

Note

1 2020 and 2021 are excluded, due to the COVID-19 pandemic.

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