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Seven Misunderstandings About the Arctic Route

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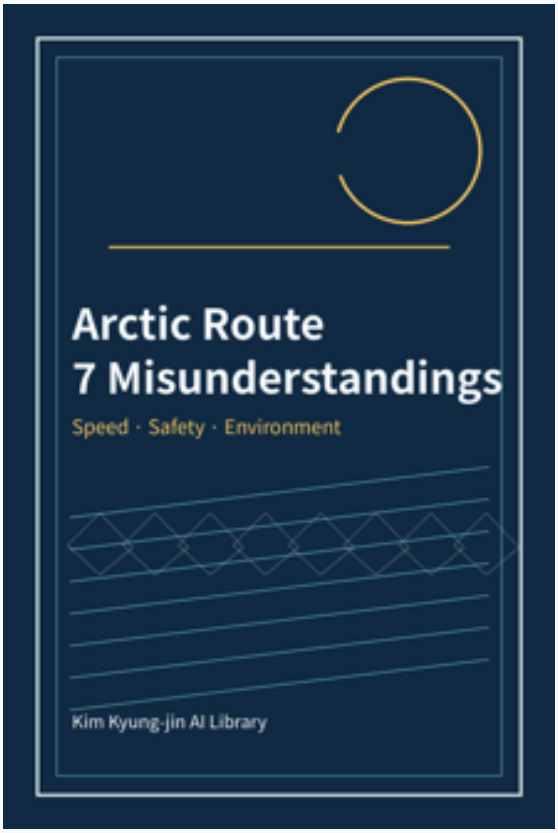

Kim Kyung-jin

English PDF edition

Seven Misunderstandings About the Arctic Route

Kim Kyung-jin

An online AI Library book by Kim Kyung-jin on seven common misunderstandings about the Arctic Route, including speed, liner service, insurance, safety rules, year-round access, carbon impact, and infrastructure.

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Preface

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Imagine a ship passing through the Arctic Ocean. A massive cargo ship moves slowly through the pure white ice. Ahead, an icebreaker paves the way, smashing through the thick frozen surface. This scene, which looks like something out of a movie, is the Arctic Route. The Arctic Route is a new maritime path connecting Europe and Asia. It is much shorter than the Suez Canal route we know so well. To travel from Busan to Rotterdam via the Suez Canal, you have to cover about 21,000 kilometers. But what if you use the Arctic Route? It is only about 12,700 kilometers. That is a staggering 40% shorter! There are different types of Arctic routes. There isn't just one path through the Arctic; there are three main types. First is the Northern Sea Route, often abbreviated as NSR. It follows the northern coast of Russia, stretching from the city of Murmansk to the Bering Strait. This is the most frequently used Arctic route today. Second is the Northwest Passage. This route winds between the islands of northern Canada and into the Atlantic Ocean. Because it requires navigating through numerous islands, it has more ice than the Northern Sea Route, making it much more dangerous and difficult to use. Third is the Transpolar Sea Route. As the name suggests, it passes near the North Pole. While it is the shortest distance, it has the most ice. Even in mid-summer, the ice does not melt, making it impossible to use. If the glaciers at the North Pole were to melt, one might wonder what the future of humanity would look like... Regardless, this route seems impossible or only feasible in the very distant future. In this book, we will primarily discuss the Northern Sea Route. This is because it is currently the only Arctic route used commercially. From here on, when I refer to the "Arctic Route," you can assume I am talking about the Northern Sea Route. Explorers Who Set Out for the Arctic Route The history of the Arctic Route dates back hundreds of years. In the 16th century, European explorers were searching for new ways to reach Asia. At the time, the Ottoman Empire dominated the Middle East, blocking land routes. Therefore, they had to find a path by sea. In 1594, Dutch explorer Willem Barentsz explored the northern seas, but he was blocked by thick ice. Despite several attempts, he did not succeed, and many crew members lost their lives to cold and hunger. Russia also joined the Arctic exploration. Peter the Great ordered the investigation of the Arctic Ocean. In the 18th century, Russian expeditions gradually mapped the northern coast of Siberia. Finally, at the end of the 19th century, a historic event occurred! From 1878 to 1879, over the course of two years, Swedish explorer Nordenskiöld successfully completed the first full transit of the Northern Sea Route. Of course, he had to spend a winter there, trapped in the ice until spring arrived. In the early 20th century, the Soviet Union began developing the Arctic in earnest. They built icebreakers and established Arctic settlements. While there were military objectives, resource development was the primary goal. In 1932, the Soviet icebreaker Sibiryakov passed through the Northern Sea Route within a single sailing season—completing the journey during the summer without wintering over. This marked the beginning of the modern Arctic Route. During the Cold War, the Northern Sea Route was mainly used by the Soviet Union to transport Siberian resources and military supplies. Foreign ships were rarely allowed to use it. In 1991, the Soviet Union collapsed, and the situation changed. Facing economic difficulties, Russia decided to open the Arctic Route to

foreign nations to generate revenue. In the 1990s and 2000s, several foreign ships tested the route, but it was not commercially successful due to high costs and risks. The 2010s: Rising Expectations The turning point came in the 2010s. As global warming caused Arctic ice to melt rapidly, much of the ice disappeared during the summer, making it much easier for ships to pass. In 2012, the Chinese cargo ship Xuelong transited the Arctic Route, drawing significant attention from China. In 2013, the Danish cargo ship Nordic Orion used the route to transport coal. South Korea also showed interest. Do you remember when an HMM (Hyundai Merchant Marine) container ship conducted a trial voyage through the Arctic Route in 2013? The media reported on it extensively, with newspapers running headlines like "The Dream Route Has Opened." In the mid-2010s, expectations for the Arctic Route were incredibly high. Many experts offered rosy outlooks, predicting that "by 2020, the Arctic Route will become a major shipping lane" and "by 2030, it will compete with the Suez Canal." The media was enthusiastic as well, using grand terms like "the Silk Road of the 21st Century" and "the Future's Golden Route," while investors showed great interest in Arctic-related businesses. However, ten years later, the situation is quite different from those initial predictions. Fewer ships than expected are using the Arctic Route. In 2023, about 2,000 ships passed through, but most of them were Russian. There were only about 100 foreign ships. During the same period, 20,000 ships passed through the Suez Canal—a tenfold difference! The Arctic Route remains a niche path and has not become a mainstream shipping lane. Why did this happen? What did the early optimism overlook? Safety issues were more serious than expected. Ice remained dangerous and moved unpredictably. The weather was also volatile. Cost was another major factor. Building specialized ships was expensive, and icebreaker fees were high. Insurance premiums were three times higher than on general routes. Although the distance was shorter, the total cost was actually higher. Environmental concerns also emerged. World-renowned shipping companies refused to use the Arctic Route, declaring, "We do not want to pollute the pristine Arctic." In an era that emphasizes ESG management, the Arctic Route was not welcomed. The political situation also worsened. With the start of the Russia-Ukraine war in 2022, Western nations imposed sanctions on Russia. Since the Arctic Route passes through Russian territorial waters, simply doing business with Russia became a risk. Why I Wrote This Book I believed a sober assessment of the Arctic Route was necessary because there are too many misunderstandings. This book examines seven representative misconceptions. First, the misunderstanding that the Arctic Route is always faster. While the distance is shorter, speeds are slower, so actual sailing time is not as short as one might think. Second, the misunderstanding that international liner services will soon be available. In reality, it is becoming an exclusive Russia-China route. Liner services are still in the distant future. Third, the misunderstanding that insurance is unavailable. It is available, but it is expensive and comes with strict conditions. Fourth, the misunderstanding that one only needs to follow safety regulations. Even if you comply with the Polar Code, risks remain. You cannot control nature with safety rules alone. Fifth, the misunderstanding that it will soon be navigable year-round. Open access throughout the year is decades away. Currently, it is only possible for about four months in the summer. Sixth, the misunderstanding that it is good for the environment. Even with shorter distances, carbon emissions are not low; rather, it destroys the Arctic environment. Seventh, the misunderstanding that infrastructure is sufficient. In reality, almost everything is lacking, including an extreme shortage of ports, icebreakers, and rescue facilities. The Irony of the Arctic Route I wrote this book for students, but I hope adults read it too, as

not many people truly understand the Arctic Route. The greatest irony of the Arctic Route issue is that it exists because of global warming. Because we used a lot of oil, the planet warmed, the Arctic ice melted, and ships were able to pass through. In other words, the Arctic Route is a product of environmental destruction. Even more serious is the paradoxical cycle. If the Arctic Route becomes active, many ships will travel through it, right? The black soot from these ships covers the white ice, causing it to melt faster and accelerating global warming. The carbon dioxide emitted by ships is also a problem. Arctic-specific vessels use more fuel than regular ones, and icebreakers consume enormous amounts of diesel. Ultimately, the more we use the Arctic Route, the hotter the Earth becomes, the more the ice melts, and the more ships travel—an endless vicious cycle. We are destroying the very path the ships travel. It is like cutting down trees to build a fire for warmth; it feels warm for a moment, but eventually, the trees disappear. The Arctic Is Earth's Treasure It is a place where polar bears, seals, and whales live. It is a place of clean ice and fresh air—the last wilderness untouched by human hands. Is it right to sacrifice this precious place for commercial gain? Is arriving a few days earlier more important than the Arctic environment? Is saving a little on shipping costs more valuable than the future of the planet? These questions are not easy to answer because economic development is also important. Trade is necessary for humanity, and more efficient routes are attractive. However, we must consider the price. The true cost of the Arctic Route cannot be calculated in money. Melting ice, disappearing animals, and destroyed ecosystems are the real costs. In the summer of 2024, the Arctic sea ice area reached a record low. Scientists warn that "at this rate, there will be almost no ice in the Arctic Ocean during the summer by 2050." Can you imagine an Arctic without ice? Where would polar bears live? Where would seals give birth? The Arctic ecosystem depends on ice. If the ice disappears, everything collapses. This also affects humans. Arctic ice reflects sunlight to keep the Earth cool, but when it disappears, the planet heats up faster. Sea levels rise, and extreme weather events increase. Knowing all this, we still attempt to develop the Arctic Route. Blinded by short-term gain, we fail to think about the distant future. It Is Your Future You who are reading this book are the generation that will live in the future. The Earth of 2050, 2070, and 2100 belongs to you. Your future is decided by the choices we adults make today. What shall we do with the Arctic Route? Shall we develop it fully, leave it as a protected area, or find a middle ground? This is a crucial question of our time. This book does not provide answers. Instead, it provides facts. It shows the reality of the Arctic Route as it is and speaks honestly about both its pros and cons. I hope that by reading this book, you can judge for yourselves. Think about whether the Arctic Route is truly necessary and if it is worth the price. Please join us in contemplating the future of the Earth. The Arctic ice is asking us: "Will you melt me to let ships pass, or will you keep me to protect the Earth?" How we answer this question depends on all of us. I hope this book is a small help on the journey to finding that answer. November 2025 Kim Gyeong-jin

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Chapter 1 It Is Not Always Fast

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1. Is the Arctic Route Really a Shortcut?

Have you ever seen a globe? On a globe, there are two ways to get from Korea to Europe. One is to head south and pass through the Suez Canal, and the other is to head north through the Arctic Ocean. When you unfold a map, the Arctic Route looks much shorter. And indeed, it is. Comparing the distance from Busan to Rotterdam in the Netherlands, you have to travel about 20,000 km if you go through the Suez Canal. However, if you use the Arctic Route, you only need to travel about 12,700 km. It's a whopping 7,300 km shorter! That distance is longer than a round trip between Korea and Japan. So, is the Arctic Route unconditionally better? Unfortunately, that is not the case. This is because a shorter distance does not always mean it is faster. Think about it: imagine there are two paths from school to your house. One follows a large main road and takes a long way around, measuring 3 km. The other is a 2 km shortcut over a mountain path. Based on distance alone, the mountain path is shorter. However, the mountain path is rough, slippery when it rains, and difficult to walk on in winter due to accumulated snow. The main road is farther but flat, has buses running, and can be walked even in the rain. Which path would be faster? It would depend on the weather and the situation. The Arctic Route is the same. While the distance on the map is short, there are many difficulties for a ship to actually pass through. Ice floats in the Arctic Ocean, the weather is hard to predict, and there is a lack of facilities to assist ships. For the 'short distance' advantage of the Arctic Route to actually translate into 'high speed,' many conditions must align. The ice must melt appropriately, the weather must be good, and help from an icebreaker (a ship that breaks ice) must be available. If all these conditions are not met, it could actually take more time than the much longer Suez Canal route. In fact, records of ships that have used the Arctic Route show many cases where it took longer than expected. Some ships had to stop in the middle and wait for an icebreaker because there was too much ice. Other ships had to wait in a safe place because the weather suddenly turned bad. Experts say, "The Arctic Route is a shortcut, but it is not always a fast road." This means it is really fast when conditions are good, but can be even slower when conditions are bad. This is the first misunderstanding and truth about the Arctic Route.

2. The Arctic Ocean Changing with the Seasons

The Arctic Ocean shows completely different faces depending on the season. It's just like how the Han River, which is frozen in winter, has flowing water in summer. Let's imagine the Arctic Ocean in winter. From November to May of the following year, the Arctic Ocean is covered with thick ice. Sometimes the ice thickness reaches 2 to 3 meters. That is as thick as a two-story building. No matter how strong a ship is, it cannot break through such ice. Even specially built icebreakers struggle. Therefore, in winter, there are almost no ships that can use the Arctic Route. What about

summer? From June to October, the ice in the Arctic Ocean begins to melt. This is due to the phenomenon called the 'midnight sun,' where the sun shines all day long. In the Arctic, the sun does not set in summer, staying bright all day. The continuous strong sunlight melts the ice. However, the ice does not disappear completely. While much of the surface ice melts, large and small chunks of ice still float everywhere. These chunks of ice are called 'drift ice.' Drift ice is ice that floats on the water and moves here and there. The period with the least ice is August and September. These two months are the best time to use the Arctic Route. Looking at the records of ships that have passed through the Arctic Route, most of them sailed in August and September. If ships can only operate for just four months, from August to November, it is difficult to use for regular shipping. Regular shipping refers to operating ships on a regular basis with a set schedule. For example, buses follow set routes at set times, right? Similarly, ships must operate regularly for customers to trust them with their cargo. If they can only operate for 4 months out of the year, what should they do for the remaining 8 months? From the company's perspective, ships would be idle, and sailors would be unable to work. Therefore, there are almost no regular cargo ships that use only the Arctic Route. Furthermore, recently, it has become harder to predict the state of the Arctic Ocean due to climate change. In some years, there is a lot of ice even in August, and in other years, there is little ice starting from July. Companies operating ships need to plan in advance, but they face great concerns because they cannot accurately predict the state of the Arctic Ocean. Scientists predict that Arctic ice will melt even more in the future due to global warming. If that happens, the period for navigation might become longer. However, the seasonal differences will likely remain significant. Because the Arctic experiences the 'polar night' phenomenon where the sun does not rise in winter, ice is bound to freeze in winter no matter how warm the Earth becomes.

3. Time Spent Waiting for Ice and Icebreakers

One of the most common difficulties faced by ships passing through the Arctic Route is 'waiting.' There is more time spent waiting than expected due to ice, icebreakers, and weather. An icebreaker is a special ship that moves forward by breaking thick ice. It has a very strong hull, is heavy, and has a very powerful engine. An icebreaker breaks the ice with its own weight as it bumps into it. It is similar to how a person breaks a sheet of ice by stepping on it. Most ordinary cargo ships passing through the Arctic Route must receive help from icebreakers. When an icebreaker breaks the ice in front, the cargo ship follows behind, moving along the path made by the icebreaker. But there is a problem: there are not enough icebreakers. Russia, which manages the Arctic Route, operates several icebreakers, but the Arctic Ocean is too vast and there are many ships wanting to pass through. So, ships have to wait their turn. Shall we look at a story from the summer of 2019 when a Korean cargo ship used the Arctic Route? This ship had to stay stopped in place for over a day waiting for an icebreaker in the sea north of Russia. This was because the icebreaker was helping another ship first. There is another issue. You have to pay a fee to use an icebreaker. This is called an 'Icebreaker Fee.' It varies depending on the size of the ship and the state of the ice, but you have to pay hundreds of millions to billions of won every time you pass through the Arctic Route. This cost is a heavy burden for companies operating ships. There is also time spent waiting because of ice. Ice in the Arctic Ocean moves according to wind and ocean currents. A large chunk of ice can suddenly drift into a place where there was no ice until yesterday. In such cases, the ship cannot pass safely,

so it must wait for the ice to move elsewhere. Sometimes they wait because of the weather. The weather in the Arctic Ocean changes suddenly. It can be clear in the morning, but a storm can blow in by the afternoon. Fog is particularly frequent, and when it's foggy, it's dangerous because you can't see ahead. In these cases, the ship must be docked in a safe place to wait for the weather to improve. This 'waiting' time cannot be accurately predicted when planning a voyage. If you're lucky, you might go straight through without waiting, but if you're unlucky, you might have to wait for days. This is one of the reasons why the Arctic Route is difficult to use. What about the Suez Canal? In the Suez Canal, you also have to wait in line when there are many ships. However, you can know in advance how long you'll have to wait, and usually, you can pass through in a few hours to a day. There is no waiting because of weather or ice. It is very important for shipping companies to keep exact times. If they cannot meet the promised date for delivering cargo, big problems arise. That is why many companies choose the predictable Suez Canal, even if the distance is longer.

4. The Conditions Hidden Behind the Word 'Fast'

"The Arctic Route is fast" is not an entirely wrong statement. However, for this to be true, several conditions are required. It's just like how the statement "A bicycle is faster than a car" is only true in a congested city center. The first condition is the season. As mentioned earlier, the Arctic Route can only be properly used during the summer months of August and September. Outside of this period, the word 'fast' itself is meaningless because ships cannot pass through. The second condition is the type of ship. Not all ships can pass through the Arctic Route. Only ships specially designed to withstand the cold weather and ice of the Arctic can sail safely. These ships are called 'Ice-Class Vessels.' Ice-class vessels have thicker hulls than ordinary ships, well-heated engine rooms, and propellers made of materials resistant to ice. However, these ships cost more to build and consume more fuel because they are heavy. Therefore, it is difficult to simply compare passing through the Suez Canal with an ordinary cargo ship to passing through the Arctic Route with a special ice-class vessel. This is because the ships themselves are different. The third condition is the state of the ice. Even in the same month of August, the amount of ice varies from year to year. In years with little ice, ships can pass quickly even without the help of icebreakers, but in years with a lot of ice, speed slows down. Ships have to zigzag to avoid ice, wait for icebreakers, and sometimes stop altogether. The fourth condition is the weather. The weather in the Arctic Ocean is very unstable. Storms, fog, and high waves frequently occur. In such weather, ship speeds must be reduced because safety is most important. No matter how hurried, one cannot recklessly sail in dangerous weather. The fifth condition is the location of the ports. When saying 'it's fast,' the distance from Busan to Rotterdam in Europe is usually compared. However, not all ships go to Rotterdam. If a ship needs to go to a port in southern Europe or the Mediterranean region, going around the Arctic Route might actually be farther. The sixth condition is the type of cargo. For some cargo, arriving at an exact time is important, such as fresh fruit or the latest electronic products. For these goods, arriving on an exact date is more important than arriving a few days early. Because the Arctic Route is unpredictable, it is not suitable for this type of cargo. The seventh condition is cost. Shorter distance doesn't always mean lower cost. If you calculate icebreaker fees, special insurance premiums, and high fuel costs, it can sometimes cost more than using the Suez Canal. As such, the statement 'The Arctic Route is fast' is true only when all conditions align perfectly. Only when the season is right, the ice is scarce, the

weather is good, you don't have to wait for an icebreaker, the destination is Northern Europe, and you can afford the costs. Therefore, experts say, "The Arctic Route is a new path with potential, but it is difficult to completely replace existing routes." It is an 'auxiliary path' that can be used for specific purposes under specific conditions. If global warming continues, ice-breaking technology advances, and more ports and facilities are built in the Arctic region, the situation might change. But for now, we must understand that many conditions are hidden behind the word 'fast.'

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Chapter 2 International Liner Service Is Still Limited

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Chapter 2: International Liner Service Is Still Limited

1. How Many Ships Actually Use the Arctic Route?

The number of ships passing through the Arctic Route is not as high as one might think. In 2023, approximately 2,000 ships traversed the route. While this number might seem significant at first glance, not all these ships are of the same type. The vast majority of vessels using the Arctic Route are Russian. Russia uses the route for domestic transportation, moving oil and natural gas extracted from Siberia to other Russian ports. Many ships also carry fish caught in the northern seas. Russian military vessels also utilize the route. Foreign ships are much rarer. Chinese vessels are the most frequent among them; in 2023, about 120 Chinese ships used the Arctic Route. Only two Korean ships passed through in 2023, while Japanese ships hardly used it at all. The variety of cargo is also limited, consisting mostly of energy resources. Liquefied Natural Gas (LNG) carriers are the most common, transporting LNG produced on the Yamal Peninsula to China and Europe. There are also ships carrying oil and coal. General cargo ships are very rare. Container ships carrying everyday items like computers, clothes, and toys almost never use the Arctic Route; these goods are still moved via the Suez Canal. Usage also varies greatly by season. Many ships pass through during the summer months from July to October, accounting for over 90% of the annual cargo volume. In winter, the ice is too thick for ordinary ships to pass, and only specially built LNG carriers with ice-breaking capabilities travel through carefully. Transit time is also significant, usually taking 20 to 30 days to complete the entire route. If ice conditions are poor, it can take over a month, and the wait for icebreaker assistance can extend this further. The size of the ships is also restricted. Extremely large vessels cannot use the route because breaking through ice requires a reinforced hull, which is difficult to implement on larger ships. Furthermore, Arctic ports are currently unable to accommodate massive vessels. In 2024, the number of ships using the route actually decreased. Following the Russia-Ukraine war in 2022, Western nations imposed economic sanctions on Russia, and European countries significantly reduced their imports of Russian energy. Consequently, the number of ships carrying Russian LNG through the Arctic Route dropped. Experts believe it will be difficult for the number of ships to increase rapidly in the near future. For now, the route will primarily be used by ships transporting Russian resources to China. Many challenges must still be addressed before international cargo ships traveling between various countries can use the Arctic Route regularly.

2. Comparing It to the Suez Canal

A comparison between the Arctic Route and the Suez Canal reveals a massive difference. The two routes are like paths from different worlds. Approximately 20,000 ships pass through the Suez Canal

annually. As of 2023, an average of 55 ships passed through the canal every day. This means that ten times more ships pass through the Suez Canal every year than the total number of ships using the Arctic Route. The volume of cargo passing through Suez is beyond imagination. In 2023, Suez handled about 1.3 billion tons of cargo, while the Arctic Route handled approximately 36 million tons. The Suez Canal carries 36 times more cargo than the Arctic Route. The types of ships are also completely different. Most ships in the Suez Canal are container ships filled with everyday goods. Many oil tankers, car carriers, grain ships, and even passenger ships also pass through. In contrast, the Arctic Route is dominated by LNG carriers and oil tankers, with almost no container ships carrying general cargo. The variety of vessels is extremely limited. The operating periods are also incomparable. Ships pass through the Suez Canal year-round—in January, August, and December alike, they are always lined up and waiting. Ships transit the canal day and night. The Arctic Route, however, can only be used effectively for a few summer months. Vessels are active for only about four months from July to October, while the remaining eight months are very difficult to navigate due to ice. Transit times also show a stark contrast. Passing through the Suez Canal takes an average of 12 to 16 hours. Even including the time spent waiting in line, one day is sufficient. Since the canal is only about 193 kilometers long, ships can pass through quickly. Traversing the Arctic Route takes 20 to 30 days. Not only is the distance much longer, but ship speeds are also slower because they must proceed cautiously through the ice. Including the wait for icebreakers, it can take more than a month. Tolls are also worth comparing. In the Suez Canal, fees are based on ship size, with large container ships paying between $500,000 and $1 million. While this seems expensive, it is an acceptable amount for the shipping industry. To use the Arctic Route, operators must pay icebreaker fees to the Russian government. These costs vary based on ship size and ice conditions, typically ranging from $500,000 to $2 million. If there is more ice, the icebreaker is needed longer, increasing the cost. Port infrastructure is another point of comparison. There are large ports at both ends of the Suez Canal, such as Port Said and Suez Port, where ships can load and unload goods, refuel, and undergo repairs. The Arctic Route has almost no proper ports, with only small ones like Murmansk and Dudinka. If a ship breaks down, it is difficult to find repair services. Insurance costs also differ significantly. General marine insurance is sufficient for ships passing through Suez, and premiums are relatively low. Ships using the Arctic Route must purchase special insurance, with premiums two to three times more expensive than general routes due to the high risk of accidents. Finally, the Suez Canal has a history of over 100 years. Since opening in 1869, it has been continuously expanded and improved. The global shipping industry plans its routes and businesses around the Suez Canal. The Arctic Route is still in an experimental stage, having been used commercially for only about ten years. The shipping industry views the Arctic Route only as a supplementary path.

3. A Special Route from Russia to China

The Arctic Route has now become a special path connecting Russia and China. Rather than an international route used by the entire world, it is transforming into a dedicated corridor between these two nations. Russia is a country rich in energy resources, with vast amounts of oil and natural gas buried in Siberia and the Arctic region. The Yamal Peninsula holds one of the world's largest natural gas deposits. To transport LNG produced here by ship, the Arctic Route is the fastest way. China is a country with high energy demands. Chinese factories use significant amounts of natural gas to

generate electricity, and gas is also needed for heating homes. China has been increasing its natural gas imports every year. The situation changed drastically with the start of the Russia-Ukraine war in 2022. European nations decided to sanction Russia and declared they would no longer buy Russian energy. From Russia's perspective, it urgently needed to find new buyers. China became an excellent customer. China did not impose sanctions on Russia and instead began buying even more Russian energy. Russia now sells the energy it can no longer sell to Europe to China, and the Arctic Route is the shortest path connecting the two. An LNG carrier departing from the Yamal Peninsula reaches China's eastern coast via the Arctic Route. If it were to go around via the Suez Canal, the distance would be twice as long. In 2023, most of the LNG carriers traversing the Arctic Route were bound for China. Approximately 25 million tons of LNG were delivered to China via the Arctic Route, and this amount is expected to increase further in 2024. Russia is continuously building new LNG production facilities in the Arctic, such as the "Arctic LNG 2" project. Once completed, this facility will produce an additional 20 million tons of LNG annually, most of which will likely be sent to China via the Arctic Route. China is also active in developing the Arctic Route. China calls itself a "Near-Arctic State," meaning a country close to the Arctic. In 2018, the Chinese government released an "Arctic White Paper" outlining its plans for the route's development. Chinese shipping companies are building ships with ice-breaking capabilities—specialized vessels that can safely navigate the Arctic Route. Chinese shipyards are also constructing ice-breaking LNG carriers ordered by Russia. Russia and China work together to develop the Arctic Route. Chinese companies invest in energy development projects in the Russian Arctic, and Russia promises a stable energy supply to China. In 2024, the leaders of the two countries met and agreed to strengthen Arctic cooperation. They pledged joint development, referring to the Arctic Route as the "Polar Silk Road." However, there are challenges to this cooperation. Due to Western sanctions, Russia finds it difficult to obtain advanced equipment. Developing energy in the Arctic requires specialized technology and equipment that cannot currently be imported. China is also cautious; becoming too close to Russia could draw scrutiny from the United States and Europe. Chinese companies are careful to avoid U.S. sanctions. There are also weather and environmental issues. If Arctic ice does not melt as quickly as expected, the route remains difficult to use. Because the pace of climate change is uncertain, long-term planning is challenging. Experts believe that for the next decade, the Arctic Route will continue to operate primarily as a dedicated route between Russia and China, with other nations finding it difficult to participate in a significant way.

4. When Will Regular International Liner Services Begin?

The day when regular international liner services navigate the Arctic Route is still far off. A "liner" refers to a ship that operates according to a fixed timetable, much like a bus or a train with precise departure and arrival times. Currently, almost all liner services worldwide use the Suez or Panama Canals. A container ship departing from Busan can arrive at the Port of Rotterdam in Europe exactly 20 days later via the Suez Canal. Shippers trust this timetable when sending their goods. For regular liner services to operate on the Arctic Route, several conditions must be met. First, schedules must be accurate. Liners must arrive on the promised date because goods manufactured in factories must reach stores by a specific time. However, navigation time on the Arctic Route varies greatly depending on weather and ice conditions. While a trip might take 20 days once, it could take 40 days

another time. This uncertainty makes it difficult to operate liner services. Second, it must be navigable year-round. Liners must operate regardless of the season. However, the Arctic Route is almost unusable in winter and can only be properly navigated during the four summer months. The other eight months are blocked by ice. Experts believe that year-round navigation will only be possible when much more of the Arctic ice has melted. According to climate change research, summer ice in the Arctic is continuously decreasing, but winter ice remains thick. It will still take decades to see an ice-free Arctic ocean all year round. Third, costs must be reasonable. Liner services must be profitable; shipping companies can only continue operations if the freight rates exceed the operating costs. The Arctic Route is extremely expensive. Icebreaker fees alone cost hundreds of millions of won per transit. Building specialized ships also costs more than twice as much as ordinary vessels. Crews must be paid hazard pay, and insurance premiums are much higher. When shipping companies did the math, they found that using the Arctic Route could actually be more expensive than using the Suez Canal. Although the distance is shorter, the total cost is higher due to various additional expenses. Fourth, infrastructure must be established. Liner services require ports, supply facilities, and repair facilities. If a ship has a problem, it must be repairable immediately, and it must be possible to refuel along the way. The Arctic Route has almost no such facilities. Aside from Murmansk, there are no proper ports. If a ship breaks down, it must travel a long distance for repairs, and refueling is also difficult. Fifth, there must be sufficient cargo. Liners are profitable only when they are fully loaded. Shippers must want to use the Arctic Route for companies to operate liners. However, most shippers prefer the proven Suez route, viewing the Arctic Route as still too risky and uncertain. If shippers do not choose the Arctic Route, shipping companies cannot launch liner services. Sixth, there must be political stability. Most of the Arctic Route passes through Russian territorial waters. If relations between Russia and Western nations are poor, using the route becomes difficult. Since 2022, political tensions have made European and American companies reluctant to use the Arctic Route. Major global shipping companies have already taken a stand. Large firms like Maersk, MSC, and CMA CGM have announced they will not launch liner services on the Arctic Route due to environmental concerns and lack of economic viability. Experts predict it will take at least 20 to 30 years—likely until around 2050—before international cargo liners use the Arctic Route in earnest. For that to happen, many things must change: more ice must melt due to climate change, Arctic ports and facilities must be significantly improved, the political situation must stabilize, and, most importantly, economic viability must be proven. Currently, the Arctic Route is used as a special-purpose route for transporting Russian resources. It still has a long way to go before becoming a global route for regular international liner services.

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Chapter 3 Insurance Is Not Impossible

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Chapter 3: Insurance Is Not Impossible

1. Can Ships on the Arctic Route Be Insured?

Ships traveling the Arctic Route can indeed be insured. Many people believe the Arctic Route is too dangerous for insurance companies to sell policies, but this is not true. Insurance is available, though the conditions are strict and the costs are high. Companies operating ships must carry insurance, as sailing without it is prohibited by international regulations. An accident involving a ship is incredibly expensive; a single vessel can cost between tens and hundreds of billions of won. The cargo onboard is also worth billions. Furthermore, if an accident causes ocean pollution, the resulting damages must be compensated. Ships on regular routes carry basic marine insurance, with premiums varying based on the ship's value and the regions it traverses. Ships on safe routes have lower premiums, while those in dangerous waters face higher costs. Ships on the Arctic Route must carry special insurance, as standard marine insurance is insufficient due to the significantly higher risks. Insurance companies classify the Arctic Route as a "high-risk area." Only a few major international insurance companies handle these policies, with Lloyd's of London being the most famous. Insurance companies in Norway and Russia also provide Arctic Route insurance. Premiums are two to three times more expensive than those for regular routes. For a ship worth 100 billion won, the annual premium for a regular route is about 1 billion won, whereas for the Arctic Route, it ranges from 2 billion to 3 billion won. The premium for a single voyage can also reach hundreds of millions of won. There are several reasons for these high costs. First, the probability of an accident is high, including risks of colliding with ice, mechanical failure due to cold weather, or encountering sudden storms. Second, rescue is difficult. If an accident occurs, help is hard to find as the distance to the nearest port is vast, and rescue ships can take days to arrive. In winter, rescue may be impossible. Third, the risk of environmental pollution is significant. An oil spill would severely contaminate the Arctic environment, and oil does not decompose easily in the frigid Arctic waters, making cleanup operations extremely difficult. Insurance companies must be able to compensate for such environmental damages. To obtain insurance, various documents must be submitted, including ship blueprints, safety equipment lists, crew certifications, and voyage plans. Insurance companies review these documents meticulously and may conduct physical inspections of the ship. Experts are sent to verify that the hull is sturdy and that safety equipment is properly maintained. If problems are found during inspection, insurance may be denied or premiums increased. Insurance contracts also come with many conditions, such as specific sailing windows—usually only from July to October. If an accident occurs outside this period, insurance claims may not be paid. Navigation routes are also restricted; ships must stick to approved paths and avoid high-risk areas with excessive ice. Sailing on unapproved routes can void insurance coverage. There are also requirements for icebreaker escorts; in areas with thick ice, ships must be

guided by an icebreaker. Failing to do so can result in a denial of compensation. Weather conditions are equally important. If major storms are forecast, departures must be delayed. Forcing a departure that leads to an accident may be considered a lapse in the captain's judgment, complicating the insurance process. Insurance companies adjust premiums annually; if there were many accidents the previous year, premiums rise. Conversely, safe sailing without accidents can lead to slight decreases. Some shipping companies operate their own insurance programs, such as the Shipowners' Mutual Protection and Indemnity (P&I) Club, where owners pool funds to support one another. Ships on the Arctic Route can join these clubs, though special regulations, additional fees, or limited compensation caps often apply. In conclusion, insuring an Arctic Route vessel is possible, but it requires extensive preparation and high costs, as all strict requirements of the insurance company must be met.

2. Special Preparations Required by Insurance Companies

Insurance companies demand a lot from ships navigating the Arctic Route, requiring them to meet safety standards far higher than those for regular vessels. First and foremost, the ship's hull must be reinforced. Arctic Route ships are built with special designs, featuring hulls two to three times thicker than standard ships and using special steel to prevent cracking upon impact with ice. The bow, which is the first part to encounter ice, is built even stronger and requires a special structure to break through. Insurance companies verify that these designs are properly implemented. Hull classification is also vital. The International Association of Classification Societies divides ships into several grades. To sail the Arctic Route, a vessel must have at least an Ice Class 1C rating. Navigating thicker ice requires 1B or 1A ratings, with 1A Super being the highest. Insurance companies require certificates issued by recognized classification societies; without them or with a low rating, insurance is denied. Engines and mechanical systems must also be specialized to operate in Arctic cold. While standard engines may freeze below -30°C, Arctic Route ships are equipped with engines that function even at -50°C. Systems to keep the engine warm are necessary, as a failure in the heating system can stop the entire ship. Backup engines are also required to ensure the ship can move even if the main engine fails. Safety equipment must be more abundant than on regular ships. Lifeboats must be specially manufactured for cold weather, as standard ones cannot withstand the Arctic chill; Arctic-grade lifeboats are insulated and have internal heating. Life jackets are also specialized. Arctic waters are so cold that a person who falls in can lose consciousness from hypothermia within minutes. Arctic life jackets include features to maintain body heat. Communication equipment is equally critical, as standard satellite communications are often unreliable at high latitudes where signals are weak. Arctic ships must be equipped with specialized satellite communication gear and emergency position-indicating radio beacons that automatically signal the ship's location in case of distress. Insurance companies require regular checks to ensure this equipment is functional. Navigation equipment is also specialized, requiring accurate charts of the Arctic region. However, since many Arctic charts are incomplete, ships must have the latest electronic charts and update them continuously. Ice-detection radar is essential for spotting ice from a distance to avoid it, as standard radar often fails to detect ice accurately. Crew qualifications are another major factor; ships must carry crew members with Arctic sailing experience. Captains and navigators must undergo Arctic navigation training as defined by the International Maritime Organization's Polar Code. Insurance companies verify these training certificates, and having untrained crew members can

disqualify a ship from insurance. Crew training covers ice navigation techniques, emergency response, and Arctic survival skills. Sufficient medical equipment is also mandatory. In the Arctic, it can take days to reach a hospital if an accident or illness occurs, so the ship must be capable of providing emergency treatment. This includes stocking ample medicines and medical devices, and it is advisable to have a doctor or nurse onboard. If a medical professional is not present, there must at least be a crew member with advanced first-aid training. Fuel must also be loaded generously. Since refueling is difficult along the Arctic Route and voyages can take longer than expected—due to ice detours or weather delays—insurance companies recommend carrying at least 1.5 times the expected fuel requirement. Food and water should also be prepared with a buffer, ideally twice the expected duration of the voyage, as rescue can take a long time in the event of distress. Environmental protection equipment is also a must, including devices to prevent oil spills and systems for processing pollutants. The Arctic is a specially protected region, and pollution accidents can lead to massive fines and compensation. Insurance companies inspect all this equipment and preparation, visiting the ship in person rather than just reviewing documents. Any deficiency can lead to higher premiums or a denial of coverage.

3. How Much Would Rescue Costs Be in Case of an Accident?

If an accident occurs on the Arctic Route, rescue costs are astronomically high—often 10 to 20 times more expensive than in regular waters. There are several reasons for this difficulty. First, there are no nearby ports; even the closest port can be hundreds of kilometers away, meaning it takes days for a rescue vessel just to reach the scene. Second, there are very few rescue vessels. Only a handful of rescue ships operate in the Arctic, mostly Russian ice-breaking rescue vessels, and if they are busy with other tasks, they cannot respond immediately. Third, rescue is impossible in bad weather. Arctic storms are incredibly powerful, with waves reaching over 10 meters, making it impossible for even rescue ships to deploy. They must wait until the weather improves. Fourth, helicopter rescues are also difficult. In the Arctic winter, there are many days when helicopters cannot fly due to severe weather, and even in summer, fog and strong winds limit their operations. Let's look at actual rescue costs. In 2018, a small cargo ship was trapped in ice in the Arctic Ocean. A Russian icebreaker was deployed for the rescue, taking three days to reach the scene and two days to free the ship. The rescue cost was approximately $2 million (about 2.8 billion won). In 2020, an LNG carrier experienced mechanical failure on the Arctic Route. While the ship could not move, it was not in immediate danger of sinking. Two tugboats were sent to tow the ship to the nearest port, a distance of about 800 kilometers. The rescue and towing costs were approximately $5 million (about 7 billion won). If a ship runs aground or is at risk of sinking, costs escalate even further. Rescuing the crew alone can cost hundreds of millions of won; evacuating crew members by helicopter costs about 100 million won per person, meaning a crew of 30 would cost 3 billion won in rescue fees alone. If oil spills, costs skyrocket. Cleaning up an oil spill in Arctic waters is extremely difficult; equipment for skimming oil does not work well in freezing water, and if ice is present, cleanup becomes nearly impossible. Experts estimate that a medium-sized oil spill in the Arctic would cost at least 1 trillion won to clean up. The 2010 Deepwater Horizon oil spill in the Gulf of Mexico cost over 40 trillion won in cleanup; a similar accident in the Arctic would likely cost even more. Environmental damage compensation must also be considered. The Arctic is home to protected animals like polar bears,

seals, and whales, and if these animals are harmed by an oil spill, massive compensation must be paid. The cost of salvaging the ship itself is also significant. If a ship sinks, it must be raised from the ocean floor, which costs tens of billions of won even in shallow waters. In the deep, freezing waters of the Arctic, salvage may be nearly impossible. The loss of the ship itself is also a factor; a modern cargo ship is worth between 100 billion and 200 billion won, and if it sinks or is beyond repair, that value is lost. Cargo losses must also be calculated; the cargo onboard can be worth tens of billions of won, and for ships carrying LNG or oil, the value can reach hundreds of billions. Any damage to cargo must be compensated. Operating losses are also significant; if a ship cannot operate due to failure, losses of hundreds of millions of won occur daily, and failure to meet transport contracts can result in penalties. Legal fees are also considerable, as an accident can involve the laws of multiple countries, including Russian law, international maritime law, and international environmental treaties. Attorney and litigation fees can reach billions of won. Insurance companies calculate premiums based on all these potential costs. Because the average cost of an accident on the Arctic Route is more than 10 times higher than on regular routes, premiums are proportionally expensive. Indeed, according to a 2023 insurance company study, the average cost of a medium-sized accident on the Arctic Route is between 10 billion and 50 billion won, while major accidents can exceed 1 trillion won.

4. Why Thorough Preparation Is Essential

Sailing the Arctic Route is impossible without thorough preparation, as a single small mistake can lead to a major disaster. The Arctic environment is extremely harsh for humans, with temperatures dropping to -40°C. In such cold, a person can freeze to death after just a few minutes outside. If a situation arises where one must leave the ship, survival is difficult. The sea temperature is around -2°C, and a person falling into this water will lose consciousness within 15 minutes and die within 30. Survival times are much shorter than in regular oceans. Ice is unpredictable. While satellite photos are used to check ice distribution, they are not perfect. Ice can suddenly converge and trap a ship; in 2018, a cargo ship was trapped for three weeks by ice that had gathered in just one day. When trapped in ice, a ship can be crushed. The pressure of ice is beyond imagination, squeezing a ship with hundreds of tons of force, which can break the hull if it is not strong enough. In 1914, the explorer Shackleton's ship, the Endurance, was trapped in ice and crushed after ten months. Weather changes are also sudden. A clear morning can turn into a violent storm by afternoon, with Arctic storms producing waves over 15 meters high that can capsize a ship. Fog is another major problem; in the Arctic summer, fog often reduces visibility to less than 50 meters, making it difficult to judge ice conditions even with radar. Difficult communication is another risk factor, as unstable satellite signals can cut off contact with headquarters or other ships, forcing captains to make all decisions in isolation. Delays in rescue are fatal. While help may arrive within hours in regular waters, one must wait days in the Arctic and survive in the meantime. Equipment failure is also more deadly; while a ship with a broken engine might drift and be rescued in regular waters, a broken engine in the Arctic means no heating, which can lead to the crew freezing to death. Losing electricity is equally dangerous, as every system on an Arctic ship—heating, lighting, communication, and cooking—runs on electricity. A power outage makes survival itself difficult. Food and water shortages are also serious concerns. If rescue is delayed, food runs out, and because Arctic seawater has high salinity and cannot be drunk directly, a failure in the desalination system means no drinking water. The

psychological pressure is also immense. In the Arctic, the sun does not set in summer and does not rise in winter; the phenomena of the Midnight Sun and Polar Night impact mental health, and accumulated stress can cloud judgment. Medical issues are also severe; if a crew member is seriously injured or suffers an emergency like a heart attack, treatment is difficult, and helicopter transport to a hospital is impossible in bad weather. Environmental responsibility is also heavy. The Arctic is one of the cleanest environments on Earth, and polluting it brings global condemnation, ruins a company's reputation, and results in massive fines. All these risks make thorough preparation mandatory. The ship must be perfectly inspected, the crew sufficiently trained, and safety equipment abundantly prepared. Multiple emergency plans must be created, and voyage planning must be done cautiously. Weather forecasts must be checked continuously, ice information received in real-time, and alternative routes prepared in advance. Communication with headquarters is also vital, with the ship's location and status reported daily and any problems communicated immediately so that headquarters can prepare support. Insurance conditions must be strictly followed; all terms in the contract must be adhered to, as violating them can void insurance coverage in the event of an accident. The Arctic Route is a challenge, but it must not become a reckless adventure. Only thorough preparation can guarantee a safe voyage.

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Chapter 4 Safety Rules Alone Are Not Enough

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1. What Is the Polar Code?

The Polar Code is a set of international rules that ships sailing in Arctic and Antarctic waters must follow. Its official name is the 'International Code for Ships Operating in Polar Waters.' In English, it is called the 'Polar Code.' The organization that created these rules is the International Maritime Organization, known as the IMO. As a United Nations agency, it creates rules concerning ships and seas worldwide. Its headquarters are in London, United Kingdom, and 175 countries are members. The Polar Code has been in effect since January 1, 2017. Before then, there were no clear international rules for Arctic navigation; each country regulated it only through its own domestic laws. Consequently, voices calling for a unified standard grew louder. Why was this rule necessary? As Arctic ice melted due to global warming, the number of ships passing through the region increased. However, the Arctic is completely different from regular seas, with many special risks such as cold weather, ice, and remote locations. General navigation rules alone could not guarantee safety. The Polar Code is largely divided into two parts. The first involves regulations regarding safety, covering ship structure, equipment, and crew training. The second involves regulations regarding environmental protection, covering oil spill prevention, waste management, and the discharge of pollutants. Looking at the safety regulations in detail, the Polar Code divides ships into three categories: Category A, Category B, and Category C. Ratings are determined based on the ice conditions a ship can navigate. Category A ships are the strongest, capable of moving while breaking through medium-thickness ice and traveling the Arctic year-round, even without an icebreaker. Category B ships have medium strength and can pass through thin summer ice, though they need help from an icebreaker in areas where ice is thick. Category C ships can travel in ice-free waters or areas with only very thin ice; most general cargo ships fall into this category. The Polar Code strictly regulates ship hull structures, providing exact standards for strength, including specific details on the thickness of steel plates, materials, and welding methods. There are also regulations for engines and mechanical equipment, which must operate in cold weather and pass tests to see how many degrees below zero they can withstand. Heating systems are also mandatory. Safety equipment regulations are detailed as well: lifeboats must be special products that withstand the cold, life jackets must be able to prevent hypothermia, and emergency rations must not freeze. Navigation equipment is also specifically regulated, requiring radar that detects ice and satellite communication equipment that operates at high latitudes. Spare batteries and generators must be sufficiently prepared. Crew training is another crucial aspect; captains and navigators must receive at least 40 hours of special training covering ice navigation techniques, Arctic weather, and emergency response. Environmental protection regulations are also strict. In the Arctic, ships must be operated more cleanly than in regular seas. Dumping oil into the sea is strictly prohibited, and even oily water from cooking cannot

be thrown away recklessly. Waste management regulations are demanding; food waste cannot simply be thrown into the sea and must be processed by shipboard systems or brought back to port. Black carbon emissions are also regulated, as black smoke from ships causes ice to melt. Clean fuels must be used, and devices to reduce exhaust gases must be installed. Failure to follow the Polar Code results in penalties. Ships are inspected when they enter a port, and if a violation is found, departure is prohibited. In severe cases, heavy fines must be paid. Russia applies its own national rules that are even stricter than the Polar Code, and since most of the Northern Sea Route passes through Russian territorial waters, these must also be followed. Russia directly inspects ships before granting navigation permits. The Polar Code is a good starting point, as it created unified standards for Arctic navigation for the first time, making it safer. However, the Polar Code has limits; following the rules does not mean all risks disappear. The Arctic remains an unpredictable place that rules cannot fully capture.

2. The Dangerous Arctic Ocean Even When Rules Are Followed

Even if all regulations of the Polar Code are perfectly followed, the Arctic Ocean remains dangerous. Rules are only the minimum safety standards, and actual risks in the Arctic are much greater than what the rules imagine. In the summer of 2018, a large cargo ship sailed the Northern Sea Route. This ship met all the requirements of the Polar Code, received a Category B rating, and was equipped with all necessary gear and a trained crew. However, an unexpected situation occurred during navigation when thick chunks of ice suddenly blocked the ship's path. This was ice that had not appeared in satellite photos, brought in overnight by wind and currents. The ship came to a halt. An icebreaker was requested, but the nearest one was 200 kilometers away and took three days to arrive. During that time, the ship was trapped in the ice, and the crew grew anxious, worrying about what would happen if the ice squeezed the ship harder. Although they had prepared everything according to the Polar Code, they had not prepared for this specific situation. Fortunately, the weather stayed good and there were no major accidents, but the company suffered significant losses due to the three-day delay and had to pay penalties for late delivery. As this case shows, rules alone are not enough. The Polar Code regulates ship structures and equipment but cannot predict every situation that occurs during actual navigation. Mechanical failure is also a major problem. The Polar Code stipulates that equipment must withstand the cold, but in reality, weather can be even colder than expected; equipment tested at minus 30 degrees Celsius may not work at minus 50 degrees. In 2020, an LNG carrier that had passed all Polar Code standards experienced engine problems on the Northern Sea Route because the fuel lines froze in the extreme cold, causing the ship to drift for several days. Human error is also unavoidable. No matter how much training they receive, crew members can make mistakes in an environment that exhausts them. If day and night cannot be distinguished, sleep patterns are disrupted and judgment becomes clouded. While the Polar Code stipulates 40 hours of training, experts say this is insufficient, as learning in a classroom without actual Arctic experience is not enough. In 2019, a cargo ship captain who had received training but was seeing real ice for the first time misjudged the situation because the ice looked different from satellite photos, steering the ship into a dangerous zone. There are also limits to rescue systems. The Polar Code requires emergency communication equipment, but this is useless if the rescue is late. There is a lack of rescue ships in the Arctic; fewer than 20 icebreakers with proper rescue capabilities

exist in the entire region, which is far from enough to cover the vast ocean. If an accident occurs, one must wait days for help. Environmental protection regulations also have a gap with reality. The Polar Code requires double hulls and response equipment to prevent oil spills, but if a spill actually occurs in the Arctic, there is almost no way to stop it. Response equipment like booms and skimmers does not work properly in ice-covered, cold water. Expert experiments suggest that less than 10% of oil spills can be properly collected in the Arctic, contrasting with over 50% in regular seas. Uncertainty in weather information is another problem. The Polar Code requires checking weather info before navigation, but Arctic forecasts have low accuracy because there are so few observation stations in such a vast area. Satellite observations can be obscured by clouds, and in the rapidly changing Arctic climate, even a forecast from a few hours ago can be wrong. In the summer of 2021, a storm suddenly arrived despite a forecast of clear weather, surprising several ships on the Northern Sea Route. Insurance is also not a perfect shield; even if you follow the Polar Code, you cannot be compensated for all losses due to numerous disclaimer clauses regarding judgment errors, regulation violations, or force majeure. Even with insurance money, the loss of reputation and business opportunities remains. Ultimately, the Polar Code is necessary but not sufficient. Following the rules is basic, but preparation beyond that is required because the Arctic Ocean always harbors unpredictable risks.

3. Unpredictable Ice and Weather

Arctic ice and weather are truly difficult to predict, even with the latest scientific technology, which is the biggest reason why Arctic navigation is so difficult. Ice is alive and moving, constantly shifting according to wind and currents; an area clear today could be full of ice tomorrow, and vice versa. While ice is observed by satellite photos taken several times a day, these have limits. If there are many clouds—common in the Arctic—ice is not clearly visible. Satellite photos show whether ice is present but cannot accurately show its thickness; what looks thin may be thick, and what looks thick may be porous and easy to break. There are also various types of ice. First-year ice freezes during one winter and melts in the summer, being relatively thin and soft. Multi-year ice has accumulated for several years and is thick and hard, making it difficult even for icebreakers to break. The problem is that it is hard to distinguish between them using satellite photos alone. Icebergs are also dangerous giant chunks of ice, 90% of which are hidden below the water surface. Even if they look small from above, they are incredibly large, and hitting one causes a major accident, as seen with the Titanic in 1912. Icebergs are still a threat over 100 years later; radar can miss them in fog or high waves. Drift ice, consisting of thousands of small pieces that block ships, is also a problem, requiring ships to reduce speed and lose time. In the summer of 2022, a shipping company planned a route that looked safe on satellite photos, but by the time the ship arrived, strong winds had brought ice into the area, forcing a three-day detour. Weather prediction is equally difficult, as the Arctic has some of the most severe changes on Earth. It can be clear in the morning and stormy by afternoon, with powerful wind speeds exceeding 100 kilometers per hour and waves up to 15 meters high that risk capsizing a ship. These storms occur suddenly, forming in just a few hours without the usual signs like dropping pressure seen in regular seas. Fog is also hard to predict, frequently occurring in summer as warm air passes over the cold sea, creating density so thick that visibility is less than 50 meters. It can appear without warning, making it difficult to see ice and requiring significant speed reductions. Temperature

changes are also severe, sometimes fluctuating by more than 20 degrees Celsius in a single day. These rapid changes cause metal to expand and contract, putting stress on the ship's hull and potentially creating cracks or weakening welds. Electronic equipment is also sensitive; extreme cold drops battery performance, while sudden warmth causes condensation that can lead to malfunctions. The Arctic's magnetic field also causes problems; closer to the North Pole, compasses become unstable and point in the wrong direction. While one must rely on GPS, its signals also weaken occasionally. Aurorae, though beautiful, are powerful electromagnetic phenomena that can interfere with communication and cut off satellite signals. In the autumn of 2023, several ships lost contact with land for several hours due to strong aurorae. Climate change further complicates matters, as past data no longer explains current patterns; scientists cannot say for sure how much ice will melt or where it will move. Computer simulations often differ from reality. Ultimately, Arctic navigation is always accompanied by uncertainty; despite the best plans, nature remains unpredictable and challenging.

4. Insufficient Maps and Communication Systems

Maps of the Arctic region are not as accurate as those of other seas, with many empty spots in nautical charts where sea depth has not been properly measured. While regular routes like the Suez Canal are measured down to the centimeter, Arctic charts often contain markings like "depth unconfirmed" or "approximate position," leading to the risk of ships hitting shallow spots. This is because the Arctic was covered with ice for a long time, making it hard to investigate the sea floor. Only recently has surveying become possible as ice melts, but the work is expensive and time-consuming; scanning the entire vast Arctic Ocean will take decades. Some areas still rely on maps made 100 years ago with outdated technology. In 2019, a cargo ship hit a hidden rock on the Northern Sea Route in a spot marked as deep sea, resulting in a torn hull and hundreds of millions of won in repair costs. Seabed topography is complex, with mountain ranges and valleys that aren't accurately marked, and depths can suddenly drop from 4,000 meters to 50 meters. Information on ocean currents and tides is also insufficient, which affects a ship's speed, direction, and ability to enter ports safely. Communication systems are another major issue. Most satellites are positioned above the equator, so at high latitudes, they are close to the horizon and provide weak, unstable signals. Satellite phone calls are frequently dropped, and the internet is slow, taking minutes to send a single email. While Russia has its own Arctic satellites, they are expensive and difficult for other countries to use. GPS accuracy also drops near the North Pole, with errors exceeding 50 meters or complete failures during solar-induced electromagnetic storms. Radio communication is limited as well; VHF radios only reach short distances, making it hard to request help in emergencies. Receiving weather faxes and real-time updates on ice or navigation warnings is difficult due to poor reception and slow data. Emergency rescue systems like GMDSS are also incomplete in the Arctic; even if a distress signal is sent, the nearest rescue centers in Norway or Canada may be thousands of kilometers away. Communication with company headquarters is often poor, hindering important decision-making. Some companies install expensive Low Earth Orbit (LEO) satellite systems that work better but cost tens of millions of won per month. Russia is building base stations along its route, but coverage is not yet universal. Accurate maps and communication are the foundations of safe navigation; for the Northern Sea Route to be as safe as regular routes, this basic infrastructure must

be established.

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Chapter 5 Year-Round Opening Is Still Far Away

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Chapter 5: Year-Round Opening Is Still Far Away

1. Is Arctic Ice Really Melting?

Arctic ice is indeed melting. This is a clear fact based on decades of scientific observation. However, it is not melting as quickly as people might imagine. Scientists observe Arctic ice using satellites, with continuous monitoring since 1979. We now have over 45 years of accumulated data. This data clearly shows a decline in ice. The area of Arctic ice in summer has decreased significantly. In the 1980s, the September Arctic ice area was approximately 7.5 million square kilometers—about 34 times the area of the Korean Peninsula. By the 2020s, it had shrunk to about 4.5 million square kilometers, a 40% reduction over 40 years. Ice thickness has also thinned. In the 1980s, the average thickness of Arctic ice was about 3.5 meters; now it is about 2 meters, nearly halving in thickness. Multi-year ice is also decreasing. Multi-year ice is thick ice that remains for several years without melting in the summer. In the 1980s, 30% of Arctic ice was multi-year ice; now it is less than 10%. The reason Arctic ice is melting is global warming. The Earth's overall average temperature is rising, now about 1.2 degrees higher than before the Industrial Revolution. This might seem like a small change, but it has a huge impact on the Arctic. The Arctic warms faster than other regions—a phenomenon scientists call "Arctic amplification." When the Earth's average temperature rises by 1 degree, the Arctic temperature rises by 2 to 3 degrees. Why does the Arctic warm faster? It is because ice reflects sunlight. White ice reflects 80% of solar radiation back into space. However, when ice melts and dark seawater is exposed, the story changes. Dark seawater absorbs 80% of sunlight. As the water warms, it melts the surrounding ice even faster. More melting exposes more water, which absorbs more sunlight—a continuing vicious cycle. Scientists call this phenomenon "positive feedback." Once started, it accelerates. This is why Arctic ice is melting rapidly. Predictions for when the Arctic Ocean will be completely ice-free in summer are also being made. Many scientists expect that by 2040 to 2050, the Arctic Ocean will have almost no ice in September. That is about 20 years from now. However, this is only the case for summer. Winter is different. A significant amount of Arctic ice still remains during the winter. Since the sun does not rise in winter, temperatures drop to minus 40 degrees Celsius, making it inevitable for seawater to freeze. The winter Arctic ice area is still about 14 million square kilometers, three times larger than in summer. While the winter ice area is also gradually decreasing, it is not as fast as in summer. The rate of melting also varies every year. Some years see more melting, and some see less. 2012 was a record year for ice loss, with the summer ice area shrinking to 3.4 million square kilometers. However, ice increased again in 2013 because the weather was cooler than usual. In 2021, more ice remained than expected as well. Such annual fluctuations are large. While the long-term trend of ice reduction is clear, the short-term variations are inconsistent. This makes planning for the Arctic Route difficult. You cannot be certain

that because there was little ice this year, it will be the same next year. Some people speak as if Arctic ice will completely disappear very soon, but scientists do not see it that way. While ice will decrease significantly in summer, it will still remain in winter. To see a completely ice-free Arctic, the Earth's temperature would need to rise by another 2 to 3 degrees from now. That would likely take until the end of this century—a time when today's children will be grandfathers and grandmothers. In conclusion, Arctic ice is clearly melting, and summer ice is decreasing rapidly. However, winter ice is still robust. The time when the Arctic Route can be used year-round is still far off.

2. Does Less Ice Mean More Safety?

Many people think that reduced ice will make Arctic navigation safer, as there would be no risk of collisions. However, it is not that simple. Reduced ice actually creates new risks. While less ice extends the period during which ships can operate—increasing from about two months in the summer in the 1990s to four months now (July to October)—it does not mean the ice disappears completely. It is a partial reduction. Some areas have significant melting while others still have plenty of ice, which creates problems. When ice remains partially, the amount of moving ice increases. Fixed ice breaks up and becomes floating ice fragments, known as drift ice. Drift ice moves unpredictably, drifting here and there with winds and currents. An area that was clear yesterday could be full of drift ice today. Ships can become trapped. In the summer of 2019, a cargo ship passing through the Arctic Route was trapped in drift ice. Satellite images showed little ice in the area, but drift ice suddenly converged, and the ship was stuck for two days. When ice melts, waves get bigger. Ice acts as a buffer against waves; even when the wind blows, waves do not grow large if ice is present. However, in the open sea without ice, high waves can form. Arctic storms are powerful, and with less ice, waves during storms become even larger. In the fall of 2020, waves 15 meters high were observed in the Arctic Ocean—such heights were rare in the past. High waves are dangerous for ships; they cause them to toss and turn, which can lead to cargo spills, crew injuries, or even capsizing in extreme cases. Ocean currents also change. Ice used to regulate the flow of the sea, but as it disappears, current patterns shift. New currents emerge, and existing ones strengthen, making them difficult to predict. In 2021, scientists discovered a new strong current in the Arctic caused by melting ice, flowing at 5 kilometers per hour. Ships traveling against this current must use more fuel. Weather also becomes more erratic. Ice helps stabilize the weather; as it decreases, temperature fluctuations grow, storms occur more frequently, and fog becomes more common. According to scientific studies, the frequency of Arctic storms has increased as ice has decreased. In the 1980s, there were an average of five storms during the summer; now there are an average of ten—a twofold increase. Fog is also an issue. When warm air meets the cold sea, fog forms, and as ice melts, fog occurs more frequently in the Arctic. Navigating in fog is difficult. Icebergs can also become more numerous. Greenland's glaciers are melting rapidly, and chunks of ice breaking off from them float into the sea to become icebergs. The number of icebergs coming from Greenland is increasing; in the 2010s, the number of icebergs rose by 30%. Icebergs are a major hazard to ships; we must remember the Titanic disaster. The environment is also changing, and the Arctic ecosystem is shifting. Fish are moving north, and new species are appearing in the Arctic. While this is an opportunity for fishing, it is a new variable for navigation. An increase in jellyfish is also a problem. Swarms of jellyfish appear in the warming Arctic waters and can clog a ship's cooling water intakes. If engine cooling fails, the ship stops. The seabed

is changing too. Permafrost is thawing, and as the frozen ground beneath the sea melts, the foundation weakens, potentially altering seabed topography and making old maps inaccurate. Methane gas is another risk factor. Large amounts of methane hydrate are buried under the Arctic seabed, and as temperatures rise, methane gas is released. Methane bubbles rise to the surface, and if a ship passes through such an area, it could lose buoyancy. Experts say that partial ice is more dangerous than a complete absence of ice. If the sea is full of ice, ships simply don't go, so there are no accidents. If there is no ice at all, they can navigate like any other ocean. However, the most difficult situation is when ice is present in patches. You must constantly check for ice and make split-second decisions, making it easy to make mistakes. In conclusion, less ice does not automatically mean more safety. Instead, new types of risks emerge. Arctic navigation will continue to be a difficult challenge.

3. Why Navigation Is Only Possible in Summer

The Arctic Route is currently only properly usable in the summer, for about four months from July to October. For the remaining eight months, navigation is almost impossible. Why is that? The biggest reason is ice. In winter, most of the Arctic Ocean is covered with thick ice, reaching two to three meters in thickness. Regular ships cannot break through such ice. Even icebreakers have limits; even Russia's powerful nuclear-powered icebreakers find it difficult to break ice thicker than three meters. Trying to force a path through can lead to the icebreaker itself becoming trapped. The extreme cold of the Arctic winter is also a problem. Temperatures drop to minus 40 degrees Celsius, with wind chills reaching minus 60 degrees. In such cold, everything on the ship freezes. If water splashes onto the deck, it freezes instantly. As ice accumulates, the ship becomes heavier, potentially losing balance and tilting. In the 1980s, a fishing boat sank due to ice buildup on the deck. Ship equipment is also vulnerable to the cold. Oil hardens, and lubricants become thick, preventing machinery from operating properly. Battery performance also drops, as batteries discharge quickly in cold environments. The crew also finds it difficult to endure. Working outside requires wearing thick clothing, but such gear makes movement uncomfortable, and frozen fingers make delicate work impossible. During the Arctic winter, the sun does not rise—a phenomenon called "polar night." It is dark all day long. Navigating while avoiding ice in the dark is truly difficult; radar alone is not enough. The darkness also affects the human mind. Continuous darkness leads to depression, which can harm the mental health of the crew, resulting in decreased concentration and increased mistakes. Storms are also stronger in winter. Arctic winter storms are as powerful as typhoons, with wind speeds exceeding 150 kilometers per hour. When accompanied by blizzards, visibility is completely lost. Rescue operations are also nearly impossible in winter. Icebreakers cannot head out in a storm, and helicopters cannot fly. If an accident occurs, you might have to wait until spring. Communication is also more difficult in winter due to changes in the ionosphere. Aurora activity is high in winter, and auroras interfere with communication, causing frequent satellite signal drops. Port facilities also do not function properly in winter. Arctic ports freeze over, and cranes freeze and stop moving, making it difficult to load and unload cargo. Fuel consumption is also much higher in winter because continuous heating is required and the engine must be run hard to break through ice. Fuel costs are more than double those of summer. Summer is different. In July, Arctic temperatures rise to about 5 to 10 degrees Celsius. Ice begins to melt, and in August and September, there is the least amount of ice.

During this time, ice disappears in many sections of the Arctic Route. Ships can pass through even without icebreakers. Of course, they must be careful, but navigation is possible. In summer, the sun does not set—a phenomenon called "midnight sun." It is bright 24 hours a day, which is good for navigation as ice is clearly visible and hazards can be spotted in advance. The weather is also relatively stable with fewer storms. Higher temperatures ensure equipment works well, and it is more comfortable for the crew to work on deck. Rescue systems also function better in summer. Icebreakers are active and helicopters can fly, making it easier to get help if a problem arises. However, summer is not perfect. Fog is frequent, sudden storms occur, and drift ice can appear unexpectedly. The summer navigation period is also short—only four months—which is insufficient for operating regular cargo liners. Shipping companies prefer routes that can be used year-round. By the end of October, the weather deteriorates rapidly. Temperatures drop sharply, the sea begins to freeze again, and storms become frequent. Ships must hurry to leave the Arctic. Remaining in the Arctic in November is dangerous, as ships can be trapped in ice. In 2014, a cruise ship stayed in the Arctic until late October and became trapped; it was rescued by a Russian icebreaker, but it was a dangerous moment. In conclusion, the fact that the Arctic Route can only be used in summer is due to natural limitations—conditions that are difficult to overcome with human technology. For the Arctic Route to be used year-round, fundamental changes are required.

4. What Is Needed for Year-Round Navigation?

For the Arctic Route to be used year-round, many things must change. Technology, infrastructure, and the natural environment must all be different from how they are now. First, much more ice must melt. Currently, significant melting only occurs in the summer. For year-round navigation, there must be less ice in winter as well. According to scientific calculations, winter ice must decrease to less than half of its current level. For that to happen, the Earth's average temperature would need to rise by more than 2 degrees from now. At the current rate, this could be possible around 2070—45 years from now. However, if temperatures rise that much, other major problems will arise: sea levels will rise, coastal cities around the world will be submerged, and climate disasters will increase. Is it worth paying such a price to use the Arctic Route? Second, many more powerful icebreakers are needed. Breaking winter ice requires icebreakers twice as strong as those currently in use. They must be stronger than the latest nuclear-powered icebreakers Russia is building. Building one such icebreaker costs over 1 trillion KRW. To cover the entire Arctic Route, at least 20 would be needed, totaling 20 trillion KRW. Who would pay for this? The cost of operating these icebreakers is also significant. A nuclear-powered icebreaker costs billions of KRW per month in fuel, crew salaries, and maintenance. Operating them year-round would incur enormous costs. Third, port and supply facilities must be greatly expanded. Currently, Murmansk is the only properly functioning port. At least 10 more ports that can operate in winter are needed. Building an Arctic port is extremely difficult as it must be built on permafrost, requiring special construction techniques and costing more than five times as much as a regular port. Each port needs de-icing cranes, as regular cranes freeze and stop working in winter. Installing special cranes that can withstand the cold costs tens of billions of KRW each. Fourth, a completely new rescue system must be created. A rescue system that operates 24 hours a day, even in winter, is needed. Rescue vessels with ice-breaking capabilities must be stationed at various locations. All-weather helicopters are also necessary—special helicopters that can fly in storms,

similar to those used by the Russian military. Preparing such helicopters for civilian use would cost a vast amount of money. Rescue bases must also be built every 200 kilometers along the Arctic Route, equipped with permanent rescue personnel and equipment. More than 20 such bases are needed. Fifth, the communication system must be completely rebuilt. Dedicated Arctic satellites are needed—satellites that send strong signals even at high latitudes. At least five satellites must be launched. A terrestrial communication network is also required, with base stations capable of 5G communication built along the Arctic Route. This too requires a massive investment. Sixth, accurate nautical charts must be created. The entire Arctic Ocean must be re-surveyed with precision using the latest equipment—a task that would take over 10 years. Ice prediction systems must also be improved. Ice movement must be predicted in real-time using supercomputers and AI to increase accuracy. Developing such a system would cost hundreds of billions of KRW. Seventh, specialized ships must be built in large numbers. Ships that can navigate the winter Arctic must be specially designed; modifying regular cargo ships is not enough. New ships must be built—container ships, tankers, and LNG carriers with ice-breaking capabilities. Each ship costs hundreds of billions of KRW, and hundreds of ships would be needed for commercial operation. Eighth, international cooperation must be achieved. The Arctic Route passes through the waters of several countries, including Russia, Norway, Canada, and the United States, and they must cooperate. However, relations between these countries are currently not good, as the conflict between Russia and the West continues. Without resolving political issues, Arctic development is also difficult. Ninth, environmental protection measures must be established. Increased shipping will pollute the Arctic environment and harm wildlife. A way to prevent this is needed. Balancing environmental protection and route development is extremely difficult, and many environmental groups oppose the expansion of the Arctic Route. Persuading them is also a major challenge. Tenth, economic viability must be proven. The money required for all of this amounts to hundreds of trillions of KRW. Can this investment be recovered? Can enough money be collected from the ships using the Arctic Route? According to expert analysis, with current technology and economic conditions, the numbers don't add up. Operating the Arctic Route year-round requires too much investment, while the profits are uncertain. In conclusion, the year-round opening of the Arctic Route is still in the distant future. While it may be technically possible, there are too many economic, environmental, and political issues to solve. It is unlikely to be seen in our lifetime.

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Chapter 6 Carbon Reduction Is Conditional

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Chapter 6: Carbon Reduction Is Conditional

1. Is a Shorter Distance Always Better for the Environment?

The Arctic Route is shorter than the route passing through the Suez Canal. Traveling from Busan to Rotterdam via the Suez Canal is about 21,000 kilometers. Using the Arctic Route, it is about 12,700 kilometers. The distance is shortened by as much as 40%. Many people believe that if the distance is shorter, less fuel is used. Using less fuel means carbon dioxide emissions are also reduced, which is good for the environment. This line of thinking makes sense, but the reality is not so simple. One cannot judge environmental impact by distance alone. In practice, various factors must be considered together. The speed of the ship is important. Ships traveling the Suez Canal route move at an average speed of 25 kilometers per hour. Because the sea is clear and safe, they can travel quickly. On the Arctic Route, they cannot go that fast because they must be cautious of ice. The average speed is only about 15 kilometers per hour. This means they travel slowly. When traveling slowly, it takes more time. The Suez Canal route takes about 35 days. Even though the Arctic Route is shorter, it takes about 30 days. Time is not saved as much as one might expect. A ship uses fuel continuously while moving. It must run the engine, generate electricity, and use energy for the crew's living requirements. If the journey takes more days, fuel consumption increases. In 2021, a research team performed actual calculations. They compared the fuel consumption of the same ship using the Suez Canal and the Arctic Route. Surprisingly, the ship used more fuel on the Arctic Route. Why did this happen? On the Arctic Route, the ship must travel slowly, but the engine must remain on. Heating must also be increased significantly due to the cold weather. The Arctic cold is severe. To keep the interior temperature warm, heating systems must run constantly, using more than twice the energy of typical routes. The ship's exterior must also be kept from freezing; it is dangerous if decks, railings, and equipment freeze. To prevent this, heating devices are installed in various places, all of which use energy. Fuel is also an issue. In the Arctic, special fuel must be used. Regular fuel solidifies in cold environments. Arctic fuel flows even at low temperatures, but this special fuel is less efficient than regular fuel. A larger quantity is needed to cover the same distance. It is also more expensive, costing over 30% more than regular fuel. Following an icebreaker also consumes a lot of fuel. The ship follows behind the icebreaker after it breaks the ice, but matching the icebreaker's speed is not fuel-efficient. Every ship has its most efficient speed; going too fast or too slow wastes fuel. In the Arctic, you cannot travel at your own pace; you must match the icebreaker and ice conditions. There is also waiting time. While waiting for an icebreaker or better weather, the ship remains stationary. Though it isn't moving, the engine must stay on to generate electricity and provide heat. In 2020, an LNG carrier waited three days for an icebreaker on the Arctic Route. During those three days, the ship sat in place but used several tons of fuel daily—this fuel was pure waste. Sometimes, detours

are necessary. If there is too much ice, the ship must go around, sometimes traveling hundreds of kilometers more than the intended route. This causes the distance-saving effect to disappear. From an environmental perspective, one must look at carbon dioxide emissions. Let's look at the 2022 findings from the International Maritime Research Institute. For a container ship traveling from Busan to Rotterdam, the Suez Canal route emits about 7,500 tons of CO2. Using the Arctic Route, it emits about 7,200 tons—a reduction of only 4%. The difference is smaller than expected. Some ships even emit more carbon dioxide on the Arctic Route, depending on the type of ship and ice conditions. If there is a lot of ice, the Arctic Route can actually be worse for the environment. Time is also an environmental cost. There are cases where cargo must arrive quickly, such as fresh fruit or pharmaceuticals. If the Arctic Route cannot save much time, such cargo must be sent by air. Airplanes emit far more CO2 than ships; for the same cargo, a plane emits over 50 times more carbon dioxide. If the Arctic Route is slow, more cargo eventually goes by air. Experts say that environmental impact should not be judged by distance alone. One must comprehensively look at actual fuel consumption, carbon dioxide emissions, and other pollutants. In conclusion, the Arctic Route is not always better for the environment; it only has environmental benefits when conditions are right. It is effective when there is little ice and the weather is good, but such conditions only last for two or three months in the summer.

2. Why Arctic-Specialized Ships Consume More Fuel

To navigate the Arctic Route, special ships are needed; standard cargo ships are not enough. Arctic-specialized ships are uniquely designed and manufactured. Not many people know that these special ships actually consume more fuel. Arctic-specialized ships have thick hulls. To withstand collisions with ice, the steel plates must be made thick. While a standard ship's hull thickness is about 20 millimeters, an Arctic-specialized ship's hull is between 40 and 60 millimeters. Thick steel plates are heavy. A heavier ship must displace more water, which takes more power. To generate that power, the engine must be run harder, consuming more fuel. An Arctic-specialized ship weighs 15% to 20% more than a standard ship. Even for ships of the same size, the Arctic version is much heavier and uses more fuel accordingly. The ship's shape is also different. Arctic-specialized ships have blunt bows designed for breaking ice. Standard ships have sharp bows designed to slice through water smoothly. A blunt bow faces more water resistance, which is 30% greater than that of a sharp bow. High resistance makes it harder to move forward, requiring more power. This is easier to understand when compared to cars: a streamlined sports car faces less wind resistance, while a boxy truck faces more. To maintain the same speed, the truck uses more fuel. Engines are also special. Arctic-specialized ships must be equipped with powerful engines to break through ice. They use engines that are over 30% stronger than those of standard cargo ships. Strong engines consume a lot of fuel. It is like the difference between a compact car and a large SUV; the SUV is powerful but uses more gas. Arctic-specialized ships run their powerful engines even in ice-free sections. Lowering the engine output can actually cause malfunctions, so they always operate at high output. Heating systems are also a major factor. Arctic-specialized ships are equipped with powerful heating units to keep the entire ship warm. Not only the crew quarters but also the cargo spaces must be kept from freezing. Some cargo must not freeze; liquid cargo expands and bursts tanks if it freezes, and mechanical parts are damaged when frozen. Maintaining all spaces at above-freezing temperatures

requires an enormous amount of energy. A 2019 study calculated the heating costs for an Arctic-specialized LNG carrier. It used about 5 tons of fuel per day for heating in the winter—150 tons a month. On a standard route, it would only use about 30 tons a month. More batteries and generators are also required. In cold environments, battery performance drops, necessitating more batteries to produce the same amount of electricity. Several backup generators must also be equipped. These generators run on diesel engines; running them frequently consumes a lot of diesel. Arctic-specialized ships run their generators more than twice as much as standard ships. Specialized equipment like ice-detection radar, heating devices, and de-icing systems also consume energy. These devices operate 24 hours a day and all require electricity. There is also a deck heating system—a device that prevents ice from accumulating on the deck by laying electric heating wires underneath. This system stays on all day. The actual sailing distance is also longer because the ship cannot travel in a straight line; it zigzags to avoid ice. The actual distance traveled is about 20% further than the shortest distance seen on satellite images. In 2020, a container ship used the Arctic Route. The planned distance was 12,700 kilometers, but the actual distance sailed was 15,200 kilometers because it had to detour due to ice and weather. Speed variations also affect fuel consumption. It is most efficient for a ship to travel at a constant speed, but in the Arctic, speed must be changed frequently—slowly when there is ice, quickly when there is not. Fuel is wasted during the process of changing speeds, especially during acceleration, just as a car consumes a lot of gas when starting. Following an icebreaker is also inefficient. Icebreakers move slowly, at 5 to 10 kilometers per hour. Cargo ships are originally designed to travel at 25 kilometers per hour. Such slow speeds are not good for the engine. Traveling at slow speeds for a long time causes carbon buildup in the engine—residue from incomplete fuel combustion. This buildup reduces engine efficiency, requiring more fuel to produce the same power. Carrying less cargo is another issue. For safety, Arctic-specialized ships do not fill their cargo to capacity, carrying only about 80% because a heavy ship is dangerous. Carrying less cargo means transportation efficiency is lower. A ship capable of carrying 10,000 tons only carries 8,000 tons. To move the same amount of cargo, more ships must be sent. According to expert calculations, an Arctic-specialized ship uses an average of 25% more fuel than a standard ship when transporting the same cargo over the same distance due to these structural characteristics. In conclusion, while Arctic-specialized ships are safe, they are inefficient. Their special design increases fuel consumption, which is a drawback from an environmental perspective.

3. Black Soot Melts the Ice

Have you ever seen black smoke coming from a ship? That is black soot, also known as black carbon. Small black particles are mixed into the smoke. Black soot is created when fuel does not burn completely. It comes from all ships, but those using diesel engines emit particularly large amounts. These particles are too small to be seen with the naked eye. In the open ocean, black soot is not a major problem because it is blown away by the wind or washed down by rain and diluted in the water. However, the story is completely different in the Arctic because the black soot falls onto white ice. When black particles cover white ice, something incredible happens. As you likely learned in science class, black absorbs heat while white reflects it. Clean white ice reflects 80% of sunlight, but ice darkened by black soot absorbs over 50% of it. Absorbing sunlight warms the ice, causing it to melt

faster. Even a small amount of black soot has a huge impact. Scientists conducted an experiment by placing clean ice and soot-covered ice under sunlight. They compared how much each melted over the same period. The soot-covered ice melted twice as fast; if there was a large amount of soot, it melted up to three times faster. It seems like a small difference, but over several summer months, it adds up significantly. As ships travel through the Arctic, they continuously emit black soot, which travels long distances on the wind and contaminates large areas of ice. A single ship emits a few kilograms of black soot a day, which seems small, but over a summer with hundreds of ships, it amounts to tons. According to a 2021 study, ships on the Arctic Route emitted about 20 tons of black soot during one summer, contaminating about 100,000 square kilometers of ice—an area similar to South Korea. Once contaminated ice melts faster, a vicious cycle begins. Melting ice reveals dark seawater, which also absorbs sunlight. As the water warms, it melts more surrounding ice. This is called a positive feedback loop, and once it starts, it is hard to stop. Black soot pulls the trigger on this cycle. Arctic animals also suffer. Polar bears live on the ice; if it melts quickly, they lose their hunting grounds. Seals also give birth on the ice, which becomes dangerous if the ice weakens. Black soot is also bad for human health. Because the particles are so small, they enter deep into the lungs, causing respiratory diseases, affecting the indigenous people of the Arctic. The International Maritime Organization is also aware of this issue and has recommended reducing black soot emissions in the Arctic since 2020, though it is not a mandatory regulation. They hope shipowners will follow it voluntarily. There are ways to reduce black soot, such as using cleaner fuel. Switching from regular marine fuel to low-sulfur marine gas oil can reduce soot by 80%. However, cleaner fuel is over 50% more expensive, so shipping companies are reluctant to switch without legal enforcement. Exhaust gas cleaning systems, called scrubbers, can also be installed to filter out pollutants from exhaust, including a lot of black soot. Installing a scrubber costs about 3 billion won per ship, and maintenance costs are also high, making it difficult for small shipping companies to afford. Some leading shipping companies voluntarily use clean fuel for environmental reasons, but they are a minority in the industry. Russian ships are also a problem. They are the most frequent users of the Arctic Route, and many of them are old. Aging engines emit more black soot. Because Russia is under economic sanctions, it is difficult to build new ships, so they have no choice but to keep using old ones. Environmental conditions worsen, but they have no other option. Scientists warn that as the use of the Arctic Route increases, black soot emissions will also rise. More ice will be contaminated and melt faster, potentially causing severe destruction of the Arctic environment. It is an ironic situation: the Arctic ice melted enough to make the Arctic Route usable, but using the route makes the ice melt even faster. Ships are essentially destroying their own path. Environmental groups oppose the expansion of the Arctic Route because the black soot problem has not been solved, arguing that use of the route should be restricted until clean technology becomes widespread. In conclusion, the Arctic Route may be shorter, but its environmental damage is significant. Black soot, in particular, threatens the Arctic ecosystem. There is still a long way to go before it becomes a truly eco-friendly route.

4. Why the World's Famous Shipping Companies Gave Up

The world's largest shipping companies do not use the Arctic Route. These include giants like Maersk, MSC, and CMA CGM. Together, these companies own more than half of all cargo ships worldwide. In 2019, Maersk announced: "We will not use the Arctic Route." It was a clear declaration.

Other large companies expressed similar positions. Why did they make this decision when they could save costs by shortening the distance? There are several reasons. First is the environmental issue. These large shipping companies have all announced environmental goals, pledging to reach net-zero carbon emissions by 2050. They emphasize ESG management—Environmental, Social, and Governance. The concept is that corporations should care for the environment and society, not just profits. Using the Arctic Route contradicts the spirit of ESG because it pollutes the pristine Arctic environment, melts ice with black soot, and threatens the habitats of Arctic animals. Large shipping companies are monitored by environmental groups and are immediately criticized if they harm the environment, which damages the company's image and causes customers to leave. In 2020, the environmental group Greenpeace launched a campaign: "Let's not buy products from companies that use the Arctic Route." European consumers responded, and some companies actually saw a decrease in sales. Large firms do not want to take such risks; the loss of image is greater than the costs saved by the Arctic Route. In the long run, it is a loss. Second is the issue of uncertainty. For large shipping companies, on-time operation is their lifeblood. They promise specific dates to customers and must pay penalties if they fail to keep them. The Arctic Route is uncertain, with many variables like ice conditions, weather, and icebreaker support. Delays of several days are common, so on-time delivery cannot be guaranteed. Major customers demand accuracy. Imagine Samsung Electronics sending smartphones to Europe; they must arrive in time for the new product launch. A delay of even one day is a disaster. Because of the Arctic Route's uncertainty, such important cargo cannot be entrusted to it; the reliable Suez Canal route is preferred. Third is insurance. Large companies prioritize safety; an accident would ruin the company's reputation. The Arctic Route is dangerous, and insurance premiums are two to three times higher than on standard routes, erasing any cost-saving effects. Furthermore, some insurance companies refuse to sell Arctic Route insurance at all. In 2021, the major insurance company Lloyd's announced: "Because the risks are too high for the Arctic Route, we will significantly raise premiums." Some ships were even denied insurance altogether. Operating a ship without insurance is prohibited by international rules. Ultimately, they must either pay expensive premiums or give up the Arctic Route. Fourth is the lack of infrastructure. Large shipping companies have global networks with offices and partners in every major port. If a problem arises, they can receive immediate support. The Arctic Route lacks such a network. There are few proper ports and a lack of repair facilities, making it difficult to resolve issues with a ship. Large companies prefer routes with established infrastructure. The Suez Canal route is perfect in every way, so there is no reason to choose the inconvenient Arctic Route. Fifth is political risk. Most of the Arctic Route passes through Russian territorial waters, requiring permission from the Russian government and assistance from Russian icebreakers. The situation worsened after the 2022 Russia-Ukraine war. Western countries have sanctioned Russia, and dealing with Russia has become risky. European and American companies are reducing Russia-related business. Paying icebreaker fees to Russia could be a sanction violation. Political situations can change at any time; a route usable today could be blocked tomorrow. Large companies dislike such uncertainty. Sixth is customer preference. The customers of these large companies are global corporations that also value ESG and do not want transportation methods that destroy the environment. In 2023, Apple announced: "The ships transporting our products must be eco-friendly." Other global companies have similar policies. Shipping companies using the Arctic Route risk losing such environmentally sensitive

customers, which is a significant long-term loss. Seventh, there are alternatives. The Suez Canal is safe and reliable. It is a bit further but presents no problems. There is also the Panama Canal. These are proven routes, and shipping companies have no reason to take risks. There is no need for dangerous experiments when a well-functioning system exists. The CEO of Maersk made an impressive comment: "The Arctic Route is good in theory but not practical. We choose what is certain." Other CEOs say similar things: "Considering environment and safety, the Arctic Route is not an option." In conclusion, the world's famous shipping companies have abandoned the Arctic Route for many reasons, including environment, safety, uncertainty, and political risk. Their decisions highlight the limitations of the Arctic Route. For it to become a major international passage, these problems must be solved, but it will not be easy. Changing the minds of these large companies will be very difficult.

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Chapter 7 Infrastructure Remains Weak

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Chapter 7: Infrastructure Remains Weak

1. What is the Arctic Route Lacking?

Navigating the Arctic Route requires many facilities, but in reality, there is almost nothing. The difference is staggering compared to conventional routes. Ports come to mind first. There are dozens of large ports along the Suez Canal route, such as Singapore, Hong Kong, Dubai, Suez, and Rotterdam. At these ports, ships can refuel, load and unload cargo, and undergo repairs. Along the Arctic Route, there are only a handful of proper ports. Russia's Murmansk is the largest, yet it is small compared to typical international ports, with few cranes and insufficient warehouse space. There is also the port of Dudinka, located at the mouth of the Yenisei River in northern Siberia, but it primarily handles Russian cargo and is difficult for foreign ships to use due to outdated facilities and language barriers. The port of Tiksi is even smaller, operating only in summer and freezing over completely in winter, with a limited cargo capacity that can handle only one or two ships a day. This lack of ports creates major problems: if fuel runs out, there is nowhere to replenish it; if food is low, it cannot be sourced; and if a ship has issues, there is nowhere to fix it. The near-total absence of repair shipyards is also critical. Major global shipping routes have many repair yards where ships can stop and resume their journey within days. In the Arctic, there are no large-scale repair yards. Murmansk has a small shipyard, but its capacity is limited; it cannot handle large ships or complex electronic equipment. In 2022, a cargo ship suffered an engine failure on the Arctic Route, and the nearest repair facility was in northern Norway, 800 kilometers away. It took a week to tow the vessel there by tugboat. Refueling facilities are also scarce. While major ports on conventional routes have 24-hour bunkering facilities, the Arctic Route has very few, such as Murmansk and Pevek. Since ships cannot refuel elsewhere, they must carry enough fuel from the start. The problem is that fuel is heavy; carrying more fuel means carrying less cargo, which reduces transport efficiency. Conversely, carrying too little risks running out during the voyage. Communication facilities are also inadequate. While satellite communication is seamless on conventional routes, allowing constant contact with headquarters and internet access, satellite signals in the Arctic are unstable. At high latitudes, communication satellites sit low on the horizon, resulting in weak signals and frequent dropped calls. The internet is even slower. Although Russia has launched several satellites for Arctic communication, using them requires expensive specialized equipment that many ships do not have. There are also very few weather stations. Accurate forecasting requires many stations; the Suez Canal route has hundreds sending data every hour, while the Arctic has fewer than 20. This is woefully insufficient to cover the vast Arctic Ocean, with hundreds of kilometers between stations making accurate forecasts difficult. Ice observation systems are also lacking; while satellites monitor ice, real-time information is scarce, and ships often receive data that is several hours old. Furthermore, there are no navigational aids. In

typical seas, buoys and lighthouses mark the route and hazards, allowing for safe nighttime navigation, but these are almost non-existent along the Arctic Route. It is difficult to install them because of the ice, so ships must rely solely on GPS and radar. Rescue equipment is also in short supply. Unlike conventional routes equipped with helicopter pads and emergency supply depots, the Arctic has almost no such facilities. In an accident, rescue teams must travel from far away, and in the freezing Arctic, time is life. Medical facilities are another issue. While conventional routes have hospitals at every port and allow for medevac by helicopter, the Arctic has few proper hospitals. Murmansk has one, but other areas are hundreds of kilometers away, making it hard to save emergency patients. Accommodation is also lacking. When ships must stay in port for days for repairs or weather, it is ideal for crews to rest on land, but Arctic ports are tiny villages with almost no hotels or restaurants. Without a place to rest, crews must stay on the ship, leading to increased stress. Transportation is also inconvenient, as many Arctic villages are not connected by roads and can only be reached by ship or plane, making it difficult to move goods or people. All these factors make the Arctic Route challenging. Commercial operations are impossible without infrastructure; a regular flow of many ships requires facilities beyond just a single vessel passing through. Experts estimate that building proper infrastructure for the Arctic Route would cost tens of trillions of won—an amount Russia cannot afford alone. International cooperation is needed, but it is not easy due to political issues.

2. Inaccurate Maps and Weather Forecasts

Accurate maps are the foundation of navigation. You must know where it is deep and where it is shallow to sail safely. However, maps of the Arctic region are inaccurate. Nautical charts show the underwater terrain, including depth, reefs, and undersea mountain ranges, helping ships choose safe paths. Charts for major routes like the Suez Canal or the Strait of Malacca are perfect, updated annually, and accurate to the centimeter. Arctic charts are different. Many areas have not been properly surveyed, and some charts were made 100 years ago when surveying technology was primitive. Many places are marked as "depth unconfirmed" or "approximate position," meaning there is no accurate information, and passing through them is dangerous. In 2018, a Canadian research team investigated Arctic nautical charts and found that over 40% of the Arctic Ocean had not undergone modern surveying and relied on old information. Inaccurate charts cause accidents. In 2019, a cargo ship ran aground on the Arctic Route in a spot marked as deep water on the chart. In reality, there was a reef that tore the hull. Although emergency repairs prevented the ship from sinking, it suffered hundreds of millions of won in damages. The seabed topography is also complex. There are undersea mountain ranges where the depth can suddenly jump from 4,000 meters to 100 meters, and these sharp changes are often not properly reflected on charts. Information on ocean currents is also lacking; while charts should show current direction and speed, Arctic charts rarely include this, leading to incorrect fuel calculations. Recently, the situation has been improving slightly as Russia and Norway conduct Arctic surveys using specialized vessels to scan the seabed. However, the work is slow. The area that can be surveyed in a year is limited, and work can only be done during the summer when the weather is good. It will take decades to survey the entire Arctic Ocean. Weather forecasting is also a problem. Accurate weather information is essential for safe navigation to avoid storms, but Arctic forecasts have low accuracy. The primary reason is the lack of

weather stations. Predicting weather requires vast amounts of current data—temperature, pressure, and wind speed from various points—but the Arctic has fewer than 20 stations, which is woefully inadequate for such a vast area. Weather in areas without stations is based on guesswork. Satellite observations have limits; clouds often block the view of the ground, and the Arctic is a very cloudy place, making accurate forecasts from satellite images alone difficult. Arctic weather is also fickle; a clear morning can turn into a sudden afternoon storm, making it much harder to predict than other seas. In the summer of 2021, despite a clear forecast, a sudden strong storm surprised several ships on the Arctic Route. Fortunately, there were no major accidents, but it was a dangerous moment. The lead time for forecasts is also short. While conventional routes have week-long forecasts, in the Arctic, even a 48-hour forecast is inaccurate, and 24-hour forecasts are often wrong. Captains say they cannot trust the forecasts because they frequently differ from actual conditions. Relying solely on forecasts is dangerous; one must rely on direct observation and experience. Wind forecasting is particularly difficult, as winds can suddenly jump from 20 km/h to 100 km/h within a few hours. Wave forecasts are also inaccurate; while strong winds usually mean high waves, the presence of ice suppresses them. Predicting wave height based on shifting ice distribution is extremely difficult. Fog is another issue, as it occurs frequently in the Arctic summer but is hard to predict, often reducing visibility to 50 meters without warning. Ice forecasting is even more complex, requiring predictions of where ice is and how thick it is. While satellites show current ice, predicting where it will move in a few days is difficult. A 2023 study showed that the accuracy of Arctic ice forecasts was in the 60% range. This means they are wrong 4 out of 10 times, which is low compared to the 85% accuracy of general weather forecasts. Ships sail with uncertain information and must stay constantly vigilant for any situation. Even with supercomputers, Arctic forecasting is difficult because the meteorological system is complex, where small changes have large impacts—a severe butterfly effect. Climate change also makes forecasting harder, as past data no longer explains current conditions, and 10-year-old patterns no longer apply. Finding new patterns takes time. In conclusion, inaccurate maps and weather forecasts make Arctic navigation dangerous. Without this basic information, safety cannot be guaranteed, and while improvement is necessary, it will not be easy.

3. Why Rescue is Difficult in Case of an Accident

If a ship has an accident in the Arctic, rescue is extremely difficult for several reasons. The biggest reason is distance. The Arctic is remote, and even the nearest rescue base can be hundreds of kilometers away. While a rescue ship might arrive within hours in other seas, it takes days in the Arctic. Russia is responsible for Arctic rescues as most of the route lies within its territorial waters. Russia operates rescue bases in Murmansk, Dikson, and Pevek, but these bases are thousands of kilometers apart. An accident in the middle could be over 1,000 kilometers from the nearest base. The speed of rescue ships is also slow; an icebreaking rescue vessel travels at about 15 kilometers per hour, meaning it takes nearly three days to cover 1,000 kilometers. During that time, the distressed ship must wait. In freezing weather, three days is the difference between life and death. If a ship is at risk of sinking, it is hard for the crew to survive. The water temperature is -2°C, and falling in means death within 30 minutes. Even getting into a lifeboat is not safe, as air temperatures are -30°C. Even with heating, it is hard to survive for days in a lifeboat, and food and water are limited. Helicopter rescue is also difficult. Russia has Arctic-capable helicopters, but they are few in number

and insufficient to cover the entire region. The range of helicopters is also an issue; they can only travel a limited distance on one tank of fuel, and there are no places to refuel midway, meaning they might not be able to reach a distant accident site. Weather is another factor. Helicopters cannot fly in bad weather, and storms or fog make flight impossible. The Arctic has many days with poor weather. In the winter of 2020, a cargo ship sent a distress signal in the Arctic Ocean. A helicopter from the nearest base tried to respond but was grounded for three days by a storm. Fortunately, the ship did not sink, and the crew held out until they were rescued after the weather cleared, but it was a close call. Rescue equipment is also lacking. Arctic rescue requires specialized gear: cold-resistant diving suits, tools to break ice, and life-saving equipment that functions in sub-zero temperatures. Not many places have this equipment; it is only available at certain bases. If an accident occurs where there is no such equipment, a proper rescue is difficult. Medical support is another problem. Rescued individuals need immediate treatment for hypothermia, frostbite, and injuries, yet rescue ships often lack doctors. It may take several more days to reach the nearest hospital, and emergency patients may not survive that time. While medical helicopters exist, they cannot fly in bad weather. Communication issues are also serious. Even if a distress signal is sent, the receiving station is far away, and a weak signal may not be transmitted properly. In 2019, a fishing boat was on the verge of sinking in the Arctic Ocean. They sent a distress signal, but communication was poor, the signal cut out several times, and it was hard to convey their exact location. By the time the rescue team arrived, the ship was already sinking. The crew was rescued by helicopter, but one person went missing. If communication had been faster, everyone might have been saved. International cooperation is also difficult. In typical seas, nearby countries help each other and rescue distressed ships regardless of nationality, as stipulated by international maritime law. In the Arctic, cooperation is difficult due to political issues. Relations between Russia and Western nations are poor, and since 2022, cooperation has almost ceased. It is difficult for Canadian or Norwegian rescue assets to enter Russian territorial waters; they need permits, which takes time, and in emergencies, time is life. Ice also complicates rescues. If a ship is trapped in ice, it is hard to approach, and an icebreaker must arrive first to break the ice, which takes more time. Even for helicopter rescues, it is hard to land on ice; one must ensure the ice is strong enough to hold the weight. Landing on weak ice will cause the helicopter to fall through. In winter, the situation is even worse as it is dark 24 hours a day, making rescue operations extremely difficult and errors more likely due to lack of visibility. Strong winds and blizzards also prevent rescue; in 100 km/h winds, even rescue ships cannot move properly and helicopters absolutely cannot fly. Rescue personnel are also limited. Arctic rescue requires specialized training in how to work in extreme cold, and not many people have this training. The Russian rescue team consists of about 500 people, which is insufficient for the vast Arctic Ocean. If accidents occur in multiple places simultaneously, they cannot respond. The cost is also enormous. Arctic rescue operations are more than 10 times more expensive than general rescues, requiring specialized equipment, long hours, and many personnel. There is also the issue of who pays; while insurance companies may pay, there are limits, and if costs are too high, the shipowner must pay directly, which could bankrupt small shipping companies. In conclusion, being rescued after an accident in the Arctic is incredibly difficult. This is a major reason why people are reluctant to sail the Arctic Route, as safety cannot be guaranteed.

4. Are There Enough Ports and Icebreakers?

To use the Arctic Route in earnest, there must be sufficient ports and icebreakers, but in reality, they are woefully inadequate. Murmansk is the largest Arctic port, located in northwestern Russia. It is an ice-free port that can be used year-round. Murmansk primarily handles oil and natural gas, and its capacity to handle container cargo is limited, with only about 10 cranes—a far cry from the dozens of cranes at large international ports. It also lacks warehouse space, making it difficult to process several ships entering at once and leading to long wait times. Dudinka is a port in northern Siberia at the mouth of the Yenisei River. it operates only in summer, from May to October, and freezes completely in winter. Dudinka is a specialized port for exporting metals from the Norilsk mines, mainly nickel and copper, and its facilities are not suited for other types of cargo. Tiksi is an even smaller port at the northern edge of East Siberia, a small town of 5,000 people with small facilities that can only accommodate small ships. Pevek is Russia's easternmost Arctic port, but it is very small and mainly unloads fuel and food, making it insufficient for commercial cargo. These are all the major ports on the Arctic Route, in stark contrast to the dozens of large ports along the Suez Canal route. Building new ports is also difficult. The Arctic is permafrost, where the ground is frozen, making it hard to build and requiring specialized construction techniques. In summer, when the ground thaws slightly, the foundation weakens; a heavy crane could sink, so deep foundations must be built at enormous cost. The climate also hinders construction, as work is only possible for 3 to 4 months in the summer because it is too cold in winter, which extends the construction period. Transporting materials is another issue; since Arctic towns have no roads, materials must be brought in by ship, leading to high transport costs—a bag of cement can cost five times more than in other regions. It is also hard to find labor, as few people want to work in the cold and lonely Arctic, necessitating high wages that drive up construction costs. Experts estimate that building one modern Arctic port costs over 1 trillion won. To properly support the Arctic Route, at least 10 more ports are needed, totaling over 10 trillion won. The icebreaker issue is also serious. Icebreakers are specialized ships that break ice to clear paths for other vessels. Russia has the world's largest icebreaker fleet, operating about 40 ships, 6 of which are nuclear-powered. Nuclear icebreakers are extremely powerful and can break ice 3 meters thick, but even 40 ships are not enough to cover the entire Arctic Route. In summer, when many ships congregate, wait times for an icebreaker occur. In the summer of 2023, some cargo ships waited for three days due to a shortage of icebreakers, wasting fuel and delaying cargo transport. In winter, the situation is worse; the ice is so thick that general icebreakers are insufficient and nuclear ones are required. However, there are only 6 nuclear icebreakers to manage thousands of kilometers of shipping lanes. Each ship covers one section, and if a request for help comes from elsewhere, they cannot go. Building new icebreakers is also not easy; it takes 10 years and over 1 trillion won to build one nuclear icebreaker. Russia is building new ones, but the pace is slow. General icebreakers are also expensive, costing around 300 billion won each, with annual operating costs totaling tens of billions of won when factoring in crew wages, fuel, and repairs. Other countries also lack icebreakers. Canada has about 10, but most are old; they have ordered new ones, but delivery will take years. The United States has very few—only two—and has admitted that more are needed to increase Arctic activity, but progress is slow due to budget issues. China is building icebreakers, having constructed a research icebreaker called Xue Long 2 for Arctic research. They are planning commercial icebreakers, but those are still in the early stages. South Korea also has the icebreaking research vessel Araon, but it is for research and lacks the capacity to support commercial

routes. Experts believe at least 100 icebreakers are needed for the Arctic Route to operate fully—more than double the current number. Achieving this would take decades and tens of trillions of won. Finding the money is another issue; it is impossible for Russia alone, necessitating international cooperation where countries pool funds to build and operate icebreakers together. However, cooperation is difficult due to political issues. Environmental concerns must also be considered; more icebreakers mean more pollution in the Arctic. Diesel icebreakers emit black soot, and nuclear ones carry the risk of radiation. In conclusion, both ports and icebreakers are insufficient. At the current level, the Arctic Route cannot be used in earnest. Large-scale investment is needed but is realistically difficult, and the lack of infrastructure will continue to hinder the Arctic Route for a long time.

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While writing this book, there was a story I truly wanted to share with you. Doesn't the term "Arctic Route" sound impressive? It often appears in the news and is frequently called the "route of the future." But what is the reality? Do you remember when Korea's Hyundai Merchant Marine first traversed the Arctic Route in 2013? It was major news in papers and on broadcasts, with headlines like "Korea has finally opened the era of the Arctic Route!" However, ten years have passed since then, and Hyundai Merchant Marine does not continue to use the Arctic Route. Why is that? Quite simply, it isn't profitable. Going once or twice is easy, but running a consistent business is a different story. Imagine you are opening a shop. It's easy to try opening for a day, but preparing to open every day and welcome customers requires much more. What is the real problem? It is true that the Arctic Route is shorter. But that alone is not enough. Slow speeds, high costs, risks, environmental destruction, and a lack of facilities... we must look at all these issues together. It's like the path from school to home. The mountain path is 2km, while the main road is 3km. Looking only at distance, the mountain path is closer. But the mountain path is rugged, slippery when it rains, and dangerous when frozen in winter. The main road might be longer, but it is safe and has buses. Which path is better? It depends on the situation. What should South Korea do? South Korea became an observer state of the Arctic Council in 2013. This status gives us the right to voice our opinions on Arctic issues. We should make good use of this position, but there is no need to rush. We don't need to jump in and invest massive amounts of money immediately. We can prepare slowly and steadily, planning for 50 or 100 years into the future. We must invest in Arctic research. Korea has the Korea Polar Research Institute and the icebreaking research vessel Araon, but their scale is small. We need to gradually expand them and foster more students who study the Arctic. Protecting the global environment is a precious value. The Arctic belongs to everyone. It doesn't belong to Korea, nor does it belong to Russia. It is a precious piece of nature that people all over the world must protect together. What happens if the Arctic ice melts? Sea levels will rise, threatening cities like Busan, Incheon, and Mokpo in our country. Weather patterns will become abnormal, with more frequent typhoons and increased flooding. Farming will also become difficult. Therefore, we must think about the environment before developing the Arctic. We must not destroy the Arctic just to make a little more money. The Arctic must remain clean even when the next generation—you all—become adults and eventually grandparents. The world's largest shipping companies, such as Maersk and MSC, have decided not to use the Arctic Route. Why? Because they believe protecting the environment is more important. The larger the company, the more they value the environment. We should do the same. What about China and Russia? Currently, the Arctic Route is primarily used by Russia and China to transport oil and natural gas from Russia to China. This trend has intensified since the 2022 Russia-Ukraine war. You might think, "Couldn't we just cooperate with China and Russia?" However, we must be cautious. South Korea is a country close to the United States. If we become too close to Russia or China, the US might not look favorably upon it. International relations are complex. We shouldn't make decisions based on one side alone. We must consider our relationships with many countries and maintain a

good balance. There is nothing around the Arctic. Another problem with the Arctic Route is that there are no places to stop along the way. Think about the Suez Canal route; it passes through major cities like Singapore, Dubai, and Suez. In these cities, goods are loaded and unloaded, ships meet, and business is conducted. What about the Arctic Route? Aside from the small city of Murmansk, there is almost nothing. Hardly anyone lives there. The entire population of Siberia is only about three times that of Seoul, and even they are widely scattered. Where there are no people, there is no market. There are no goods to sell and none to buy. Ships simply pass through without any opportunities for trade. This is a major weakness of the Arctic Route. The Suez Canal is important not just because it is short, but because it connects many countries and cities, offering many business opportunities. The Arctic Route lacks this. Does that mean the Arctic Route is useless? Not entirely. It can be useful for special cargo, like Russian oil or natural gas. However, the items we use in our daily lives, like phones, clothes, and toys, will continue to come through the Suez Canal. The Arctic Route cannot replace the Suez Canal. Instead, it will remain an auxiliary route used sparingly for specific purposes. Thus, we don't need to place too much expectation on the Arctic Route. Instead, we should think about how to better utilize the currently successful Suez Canal route. Developing more efficient ships and eco-friendly vessels that use less fuel is more realistic. The Arctic is a place to be researched. The Arctic is not an object to be conquered. We shouldn't think of it only as a path for ships. The Arctic is a place with much to learn. We can study climate change in the Arctic and observe unique animals that live only there. We can learn about the Earth's past and predict its future. I hope Korea becomes famous as a country that researches the Arctic—not just a country that uses it, but one that understands and protects it. Some of you reading this book might become Arctic scientists in the future, environmental activists who protect the Arctic, or public officials who create good policies. I have a request for you. Whatever path you choose, please remember one thing: the Arctic is a truly precious place. We must not treat it carelessly just because it might be profitable right now. Imagine the white ice of the Arctic sparkling in the sunlight. Picture a polar bear walking across the ice. Shouldn't that beautiful sight be something your children and grandchildren can see too? No one knows for sure what the future of the Arctic Route will be, but it is certain that the Arctic environment is precious. Please never forget this. I hope you have thought about many things while reading this book. Do not be misled by impressive-sounding words; think calmly. Think of the environment first. Look toward the distant future, not just the immediate present. The Arctic is not a place where we need to rush. We can approach it slowly, carefully, and responsibly. That is the truly wise choice. I hope that when you become adults, the Arctic remains as beautiful and clean as it is today. That is my greatest wish in writing this book. November 2025, Kim Kyeong-jin. Written to organize thoughts on the Arctic.

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