

a Study ON THE DESIGNATION OF

tRAFFIC ROUTE TO SECURE MARITIME

TRAFFIC SAFETY

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A dissertation submitted to the World Maritime University in partial fulfilment

of the requirements for the award of the degree of Master of Science in Maritime Affairs

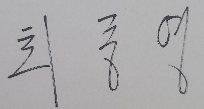
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# Declaration

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

(Signature):

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The knowledge acquired by studying at WMU will nourish the establishment and implementation of the best policies so that the Korean people can enjoy a safe and happy life. Once again, I thank the Korean government and the people for providing me with an opportunity that I will never have again.

# Abstract

Title of Dissertation**: A Study on the Designation of Traffic Route to Secure Maritime Traffic Safety**

Degree: **Master of Science**

This study aims to review measures to secure maritime transportation areas, an important task that the Korean government should pursue. The Republic of Korea is a peninsula surrounded by sea on three sides, and at the same time, the two Koreas are divided due to political issues. Korea has geographical characteristics that do not allow access to other countries through land. According to the geographical and political characteristics of Korea, an island-like logistics environment is established. Therefore, 99% of the logistics depend on the shipping industry, and various activities such as fishery, marine tourism, and island travel are carried out in the sea.

However, the marine traffic environment in the coastal waters of Korea has changed recently due to the creation of offshore wind farms, the revitalization of marine tourism, and the introduction of autonomous ships. In order to cope with these changes, the Korean government has set a plan to designate seas where ships are frequently navigated as Maritime Traffic Route (MTR) as a major policy of the country. In order to prepare reasonable improvement measures that can coexist with stakeholders such as fishermen and marine development companies, a method of designating the marine traffic area for MTR will be reviewed.

Next, the legal and administrative definition of MTR that fits the characteristics of the maritime traffic area will be reviewed. The management of MTR is a policy that the Korean government intends to newly promote. All policies of the Korean government must have a basis for their implementation in the law, and appropriate laws are needed to promote new policies. When it comes to enacting a law, the first necessary factor is to define the MTR. Through this study, a wide range of domestic laws, regulations of other countries, and international regulations will be reviewed to prepare the definition of MTR in consideration of the legal enactment procedure.

This study is to support the policies that the Korean government should actually pursue. However, it is expected that the Republic of Korea's policy to identify and systematically preserve marine traffic areas will serve as an exemplary case for other countries that want to create a safe marine traffic environment.

**KEYWORDS**: Traffic Density, Marine Spatial Plan (MSP), Offshore Wind Farms, Marine Autonomous Surface Ship (MASS), Coastal water

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# List of Abbreviations

|  |  |
| --- | --- |
| AIS | Automatic Identification System |
| EU | European Union |
| GIS | Geographic Information System |
| IEA | International Energy Agency |
| IMO | International Maritime Organization |
| IPCC | Intergovernmental Panel on Climate Change |
| ISM | International Safety Management |
| KDI | Korea Development Institute |
| KPI | Key Performance Indicator |
| MARPOL | International Convention for the Prevention of Pollution from Ships |
| MASS | Maritime Autonomous Surface Ship |
| MOF | Ministry of Oceans and Fisheries |
| MSP | Maritime Spatial Planning |
| MTR | Maritime Traffic Route |
| PSC | Port State Control |
| ROK | Republic of Korea |
| SOLAS | International Convention for the Safety of Life at Sea |
| TONNAGE | International Convention on Tonnage Measurement of Ships |
| TSS | Traffic Separate Scheme |
| UNCTAD | UN Trade and Development |
| VHF | Very High Frequency |

# Chapter 1 Introduction

## 1.1 Background of the Study

The shipping industry accounts for 80% of international trade by volume (UN Trade and Development [UNCTAD], 2022). In particular, 99% of Korea's traffic volume is carried out through shipping, and about 20 million people visit the island every year by ferry. Each person consumes about 70 kg of seafood per year through fishing using fishing vessels, showing a very high level of fishery consumption worldwide (Korean Government, 2022). As such, ships are a key resource of national logistics, a means of transportation for islanders, and a resource that helps the Korean people to consume nutrients through marine products and supports the lives of fishermen who consider the sea as a base for their lives.

Geographically, the Republic of Korea (ROK) has a peninsula-shaped land surrounded by sea on three sides, and politically and diplomatically, it has been a divided country between the South and the North since the 1950 Civil War, and it is not possible to trade with other countries through land. Considering the geographical characteristics of the land and the political and diplomatic environment, the ROK has the same characteristics as an island in terms of logistics (Kim, 2016). In addition, thousands of merchant ships and fishing vessels operate daily in the coastal waters of Korea, which are surrounded by Japan, a traditional maritime power, and China, which has rapidly emerged as the world's largest market. Currently, the maritime transportation area in the coastal waters of Korea is facing a rapid transition period. Large-scale offshore wind farms are being built in coastal waters in accordance with the global movement toward eco-friendliness, and the demand for marine tourism, such as leisure boats, is increasing rapidly as national income increases, and R&D and area setting in preparation for autonomous ships are being considered. Changes in the maritime transportation environment in the coastal waters of Korea are raising the need for the Korean government to manage maritime transportation areas.

## 1.2 Problem Statement

The Korean government annually evaluates the performance of marine safety policies, and ship inspection and seafarer training such as Port State Control (PSC), International Safety Management (ISM) Audit, Inspection, and Seafarer Training are classified as major achievements of the Ministry of Oceans and Fisheries (MOF) (Korean Government, 2023). The ROK is conducting PSC on 2,050 ships in 2022 and has been promoting 860 International Safety Management (ISM) audits and training for seafarers (Korean Government, 2022). In addition, the government's performance, such as ship inspection, is reflected in the Key Performance Indicator (KPI), an indicator that evaluates the government's performance.

However, a number of offshore wind farms are expected to be located in the coastal waters of ROK, where the traffic density is very high, with about 70% (86 out of 127) of wind meters installed in advance for the development of offshore wind farms, hindering the actual passage of ships (Korea Maritime & Ocean University, 2020). In addition, the number of ships engaged in shipping and fishing industries, such as merchant ships and fishing vessels, has been on the decline due to the enlargement of ships and policies to reduce fishing vessels, while the number of ships for tourism and leisure, such as yachts and motorboats, has been on the rise (Korean Government, 2022). More people recognize the sea as a place for tourism and leisure than those engaged in commercial and fishing activities, and this gap is widening over time. Autonomous ships are recognized as a key technology that will change the paradigm of Korea's shipbuilding and shipping industries in the future (Korean Government, 2020). The Korean government has enacted a new law, ‘The Act on Promotion of Development and Commercialization of Autonomous Vessels, to establish the route of autonomous ships on coastal water for the commercialization of autonomous ships (National Law Information Center, 2024). Such problems occurring in the coastal waters of Korea are related to the management of maritime traffic areas, which are not suitable for dealing with maritime safety policies such as ship inspection. It is time for a different kind of maritime safety policy from existing maritime safety policies to solve the above problems in the maritime safety field facing the ROK (Korean Government, 2022).

## 1.3 Purpose of Research

In order to cope with the changing maritime traffic environment, the Korean government has set the task of setting up a Maritime Traffic Route (MTR) to secure a safe area for ships to pass through the coastal waters of the ROK. This task is very important to the MOF, which oversees maritime safety administration. This is because it will present a milestone in expanding the scope of maritime safety administration from existing ship and seafarer-centered maritime safety policies to marine areas where maritime traffic takes place. In this study, the MTR policy that MOF intends to promote will be reviewed to suggest the solution to how the MTR policy can substantially contribute to improving the safety of maritime traffic in the coastal waters of Korea.

## 1.4 Scope of Study

MTR will be a maritime traffic area established in all coastal waters of Korea. If MTR is designated in the same way as existing legal routes, the government must pay compensation to stakeholders related to the sea area designated as MTR (Supreme Court, 2002). This is because if designated in the same way as a legal route, activities such as fishing, development, and leisure are prohibited or restricted. MTR policy implementation will not be possible due to problems such as enormous compensation for all waters designated as MTR. In this study, the method of designating MTR will be reviewed, and the elements necessary to establish its definition will be examined. This study aims to clarify the transportation area of Korea's shipping logistics, secure a safe maritime transportation route for the marine industry, such as shipping and fishing, and review ways for stakeholders such as fisheries and marine developers to coexist with each other.

## 1.5 Significance of Study

The shipping industry accounts for 99% of Korea's logistics. The bigger the size of the industry, the greater the importance of shipping in charge of logistics. In addition, the paradigm of the shipping industry will shift from the traditional concept of seafarers and ships to the concept of an automatic logistics system such as MASS. Considering the problems faced by Korea’s coastal society, such as offshore wind farms and marine leisure tourism, discussion on how to manage Korea’s coastal water will deepen. Recognizing this problem, the Korean Government reflected the policy on the creation of MTR in the national task (Korean Government, 2022). The national task is a public promise made by the government to the people for five years and must be implemented within this presidential term (May 2022 to May 2027). Most of the central government's policies involve laws and large budgets. The MOF invests millions of dollars in research to improve maritime traffic safety every year. Such research should not be limited to the research level but should be followed by parliamentary consultations to enact laws and secure budgets for policy implementation based on research. In order to enact laws and reflect the budget, it is necessary to persuade the financial authorities and the National Assembly, so specific measures to implement policies for MTR must be prepared. In this study, the existing research on the policy of designation of MTR and the definition of MTR will be reviewed in the process of promoting policies such as law enactment and budget reflection.

## 1.6 Structure of the Study

The main contents of each chapter are as follows, which consists of 6 Chapters. Chapter 1 examines the importance of maritime transport logistics, which forms the basis of the Korean economy, and analyses the problems that may arise in the present and future of the maritime transport environment in the coastal waters of Korea. Through these discussions, the necessity of policies on maritime traffic area management will be analyzed. Chapter 2 examines the research results related to the MTR policy to ensure maritime traffic safety and reviews similar policies and research being pursued by other governments such as Europe. Chapter 3 reviews the methodology to examine the differences by comparing and analyzing the marine traffic flow and density formed in the coastal waters of Korea by ship type. In addition, through legal analysis, the method of defining maritime traffic areas in domestic and international laws and regulations will be reviewed. Chapter 4 compares the traffic flow and density of each ship type and analyzes what kind of traffic flow is formed for each ship type. In addition, by analyzing the coastal environment, such as the development of offshore wind farms, the definition of MTR suitable for the situation in Korea is reviewed. In Chapter 5, based on the analysis results in Chapter 4, measures to improve the MTR policy and the legal nature of MTR will be discussed. Chapter 6 summarizes the results of this study and presents future tasks for better MTR policy.

## 1.7 Limitations of the Study

The coastal waters of Korea are very dense in ship traffic around the world. In addition to merchant ships, measuring the actual ship traffic density is challenging as it is an area where various types of ships, such as fishing vessels and leisure boats from three countries, Korea, China, and Japan, pass through. Ship operation information, such as fishing vessel operation records, is managed as non-public information, so only specific times and limited ship operation records disclosed by the Korean government can be used for this study. In addition, it is difficult to compare them in the same way because the method of processing ship operation information is different for each type of ship, such as cargo ships, passenger ships, fishing vessels, and leisure boats. Additionally, this study aims to examine how to establish MTR within the Korean territorial waters. Therefore, the spatial scope of this study is limited to the coastal waters of Korea, and the analysis of the marine traffic environment in the region considered by the Korean government as an MTR will be conducted in more detail. This study is to review the MTR policy and plans to use the same system that the existing Korean government used when setting up the MTR. Both these systems and data are operated by the Korean government and related research institutes. During the study period at WMU, it may be challenging to derive sufficient results due to limited access to research information such as ship operation records and government-operated systems such as ship density analysis systems. However, the results and research methods derived from this study can be used for the efficient execution of MTR policies if all information and systems are accessible after returning to the government after the completion of the WMU study. Since the various statistics and data used in this study are due to the non-disclosure reports and internal statistics of the Korean government, prior consultation with the Korean government is required before utilizing the relevant information.

# Chapter 2 Literature Review

Due to the high density of ship traffic formed in the coastal waters of Korea, dangerous situations frequently occur where ships and ships encounter. (Park et al., 2015). Factors such as the development of offshore wind farms, the increase in the operation of small ships such as leisure boats, and the preparation of MASS are affecting the marine traffic environment in the coastal waters of Korea. (Korean Government, 2022). The Korean government reflected on establishing the MTR in the national task to secure essential maritime transport areas to create a safe transportation environment in which various ships, such as leisure boats and fishing vessels, can safely navigate. To this end, the Korean government and related research institutes and universities conducted various studies necessary to designate MTR (Korean Government, 2022). This chapter intends to review the contents of the research conducted in relation to the designation of MTR.

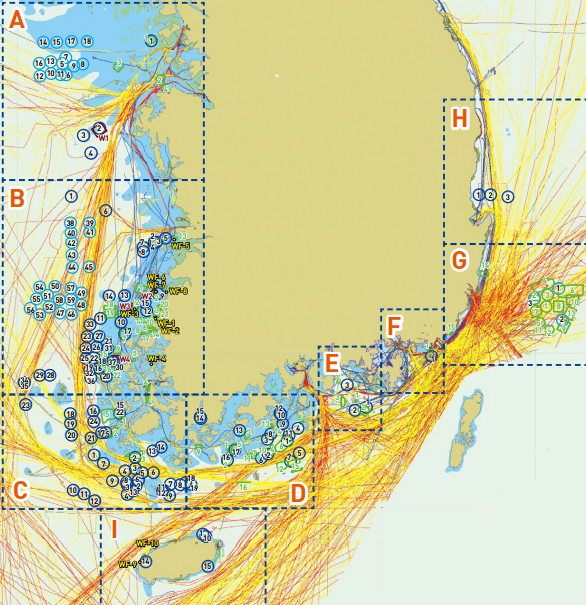
First of all, factors that are causing changes in the maritime safety administration in Korea, such as the development of offshore wind farms, leisure boat operations, and autonomous ship development that affect the current marine traffic environment in coastal waters, will be reviewed. In addition, the improvement measures will be analyzed by analyzing the traffic density survey method, which is the base of the designation of MTR. Finally, by analyzing maritime traffic policies promoted by other countries such as Europe and China, this study will examine the definition of MTR, considering the characteristics of MTR reviewed by the Korean government.

## 2.1 Changes in Maritime Traffic Environment in Coastal Water of Korea

## 2.1.1 Building a Large-scale Offshore Wind Farms

According to the Korea Energy Economics Institute, due to the depletion of fossil fuels, which are raw materials for existing power generation methods, the unit price of each power source will continue to rise. Nuclear power generation is less polluting and more advantageous in transportation and storage than fossil fuel. However, it poses a great risk, such as exposure to radioactive substances in terms of management (Yun, 2020). The Intergovernmental Panel on Climate Change (IPCC) warns that climate change will cross the threshold if net zero is not achieved by 2050, and the International Energy Agency (IEA) proposes expanding renewable energy as an efficient way to net zero. Solar and wind power are the focus of renewable energy technology in any country (Kim, 2023). Moreover, the capacity factor of offshore wind farms is significantly higher than onshore wind or solar power. According to the IEA, the capacity factor of solar power is 17%, onshore wind power is 25%, and offshore wind farms reach 40-50% (Kim, 2023). To increase the share of renewable energy generation to 20% by 2030, the Korean government has established a plan to supply more than 95% of new power generation capacity with renewable energy such as solar and wind power (Korean Government, 2019). According to the project, offshore wind farms, one of the new renewable energy sources, are being built in Korea along the country's coastal waters to produce eco-friendly energy (Korean Government, 2023). If carried out as planned, at least 2,000 wind turbines are expected to be installed along the nation's coast, which is expected to occupy about 3,200 km2 of coastal water. This is more than five times the area of Seoul, the capital of ROK (605 km2) (Korean Government, 2022)

Figure 1: Current status of offshore wind farms and wind force measuring instruments



Source: Korean Government (2023)

The offshore wind farm complexes will be installed in close coastal water. This is because construction costs increase when installed in distant seas, and it is also inefficient in maintenance, repair, and operation (Ohn et al., 2018). It is causing friction between shipping companies and fishermen's society as all ships are prohibited or conditionally allowed in complexes operating offshore wind farms complexes or scheduled to be installed in the future (Korean Government, 2022).

## 2.1.2 Promotion of policy following the spread of Marine Tourism Culture

ROK's Gross National Income (GNI) per capita exceeded $30,000 in 2018 (Bank of Korea, 2019). According to the Korea Development Institute (KDI), people are paying attention to marine leisure tourism, starting with a GNI of $30,000 (KDI, 2010). This trend is appearing directly in Korean society. Recently, the number of ships engaged in shipping and fishing industries, such as cargo ships and fishing vessels, has been on the decline due to the enlargement of ships and policies to reduce fishing vessels, while the number of ships for tourism and leisure, such as yachts and motorboats, has been on the rise (MOF, 2022*).* According to data released by the MOF, the number of cargo ships and fishing vessels (Table 1) and the number of seafarers (Table 2) are decreasing. However, the number of leisure boats (Table 1) and those who obtain licenses to control leisure boats (Table 3) are increasing.

Table 1: Status of Ship Registration

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Year | Cargo ship | Fishing vessel | Leasure boat | Total |
| 2018 | 8,985 | 65,906 | 27,515 | 102,406 |
| 2019 | 8,865 | 65,835 | 28,876 | 103,576 |
| 2020 | 8,880 | 65,744 | 31,503 | 106,127 |

Source: MOF (2022)

Table 2: Status of Seafarers’s employment

|  |  |  |  |
| --- | --- | --- | --- |
| Year | Seafarers on a Korean flag ship | Seafarers on a Foreign flag vessel | Total |
| 2018 | 31,795 | 2,956 | 34,751 |
| 2019 | 31,214 | 2,909 | 34,123 |
| 2020 | 31,035 | 2,530 | 33,565 |
| 2021 | 30,337 | 2,173 | 32,510 |
| 2022 | 29,919 | 1,948 | 31,867 |

Source: MOF (2023)

Table 3: Current Status of Acquisition of Motor Boat and Yacht Pilot License

|  |  |  |
| --- | --- | --- |
| Year | Motorboat | Yacht |
| 306,927 | 19,253 |
| 2018 | 21,241 | 1,532 |
| 2019 | 17,822 | 1,130 |
| 2020 | 20,406 | 1,369 |
| 2021 | 21,313 | 1,641 |
| 2022 | 19,420 | 1,700 |

Source: Korea Coast Guard (2023)

This trend is also noticeable regarding infrastructure expansion, such as ports and berth facilities. Marina ports for using leisure boats such as yachts and motor boats are expected to increase nearly ten times over the next ten years (8 ports in 2020 → 70 ports in 2029) (Korean Government, 2020)

## 2.1.3 Introduction of Maritime Autonomous Surface Ship (MASS)

IMO has been leading the digitalization of the shipping industry. Recently, the international shipping community has stepped up the development of autonomous ships. In 2021, IMO conducted a regulatory scoping exercise on MASS. “MSC 107th (June 2023) made further progress on developing a Goal-Based instrument regulating the operation of MASS. The aim is to adopt a non-mandatory goal-based MASS Code to take effect in 2025, mandatory goal-based MASS Code, expected to enter into force in 2028” (IMO, 2024). In response to IMO's active movement in MASS development, each country is focusing its capabilities on MASS development to create added value through pre-empting MASS technology standards. The Autonomous Ship Market size is estimated to be USD 3.9B in 2022 and is projected to reach USD 8.2B by 2030 (MarketsANDMarkets, 2023). By 2035, MASS will have an economic effect of about USD 4.8B on shipbuilding, creating 420,000 jobs and about USD 8.7B on the related industry (Korean government, 2022).

In Norway, the First Autonomous Ship Development Project, "Autonomous Ship Development Project," was operated (Munim, 2019). Also, the ROK has been running ‘the Korea Autonomous Surface Ship Project’ to develop intelligent navigation, Engine automation, and Operation techniques (Korean government, 2020). One of the shipping companies in the ROK succeeded in the world's first transoceanic voyage of a large merchant ship employing autonomous navigation technologies in 2022. In Japan, the project MEGURI2040 is operated by the Nippon Foundation, aiming to implement fully autonomous navigation (Nippon Foundation, 2022). In 2022, it succeeded in operating an autonomous container ship without seafarers for the first time in the world. In January 2024, the Korean government enacted the Act on Autonomous Ships for the early development of autonomous ships. According to this law, the government can support the budget for the development and commercialization of autonomous ships, and in particular, it can separately designate the waters that will be used by autonomous ships (National Law Information Center, 2024). Autonomous ships are expected to bring about a major change in the marine transport environment in the coastal waters of Korea. In the complex coastal waters of Korea, the operation of autonomous ships and traditional ships such as fishing vessels will intersect, and to solve this problem, it is necessary to manage the marine transportation area in the coastal waters (Korean Government, 2022).

## 2.1.4 Research Gap (Need to change Korea’s Maritime Safety Policy)

Korea's existing maritime traffic safety policy has been promoted with an emphasis on the operation of ships itself, such as ship inspection and system review. These major maritime safety policies are managed by the government's official KPI and are being evaluated by external administrative agencies such as the Prime Minister's Office. However, factors such as offshore wind farms, the increase in the operation of leisure boats, and the introduction of MASS are related to managing maritime traffic areas. It is not easy to manage with existing maritime safety policies such as ship inspection and seafarer training. Eventually, a discrepancy arises between the expected problem and how to respond to it. The Korean government understands this situation and is considering expanding maritime safety policies into the field of maritime traffic area management (Korean Government, 2022).

## 2.2 Traffic density analysis for designation of the MTR

The Korean government plans to designate MTR as areas with high ship traffic density due to the large amount of ship traffic in the coastal waters. Studies were conducted to measure ship traffic density based on this policy. According to the analysis of the traffic density conducted at the request of the Korean government, the traffic density is calculated by dividing the coastal waters of Korea into cells of 1 km X 1 km cell unit and considering the passage of ships in each cell (Korean Government, 2022). In 2022, the MOF promoted a study to calculate the ship’s traffic density for each cell by dividing the coastal waters of Korea into about 500,000 (493,370). The information used to calculate the traffic density was prepared based on the AIS information installed on the ship. In this chapter, the three methods of calculating the ship’s traffic density and the actual traffic density in the coastal waters of Korea will be reviewed.

## 2.2.1 Spot density analysis

The AIS information used for ship traffic density basically expresses the ship's navigation trajectory in the form of dots. Therefore, it has the advantage of being easy to calculate the density because it can be used without converting basic information so that the current ship passage density can be analyzed closely with the basic information (Korea Maritime & Ocean University, 2023). As shown in the figure below, spot density analysis is a method of expressing the number of AIS information in the form of spots taken in a certain area as density. After all, it is a method in which the number of points taken in the area is calculated as density.

Figure 2: Spot Density analysis (Number of spots in the cell = Traffic Density)

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Source: MOF (2023)

However, except for anchoring, the general navigation type of ship is in the form of a line, so there is a risk of distorting the actual operation status of the ship. In fact, in some cases, navigation information of AIS expressed by dot suddenly disappeared for unspecified reasons or was displayed in waters different from the actual location, just as was controversial in the Ferry Sewol accident (Korea Maritime Safety Tribunal, 2014). In addition, if two or more ships pass through the same cell simultaneously, all ships are expressed as the same dot, making it impossible to distinguish each ship.

## 2.2.2 Line density analysis

Line density analysis is a method that expresses the number of times the corresponding line has passed through the cell as the density by connecting the ship's point-type navigation information of AIS with a line. It is a method of expressing the traffic volume based on the number of crossings in the area of the cell (Korea Maritime & Ocean University, 2023).

Figure 3: Line Density analysis (Number of lines across the cell = Traffic Density)

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Source: MOF (2023)

**I**f ships passed quickly through the cell area and the ship did not stagnate in the cell at the same time, the operator would perceive that the density was low. On the other hand, if the ship passed through the cell at a slow speed and many ships stayed in the same cell at the same time, the operator would perceive that the density was high (Korea Maritime & Ocean University, 2023). However, if the line density analysis is used, the density is judged only by the number of ships passing through the cell at the same time, so the time the ship stays in the cell is not reflected. It may be different from the density experienced by the actual operator.

## 2.2.3 Space-time density analysis

The space-time density analysis method expresses the density by the time that a ship stays in the cell. It expresses the traffic density by summing the hours of stay in the cell of all ships that have passed through the cell.

Figure 4: Space-Time Density analysis (Total time spent in the cell = Traffic Density)

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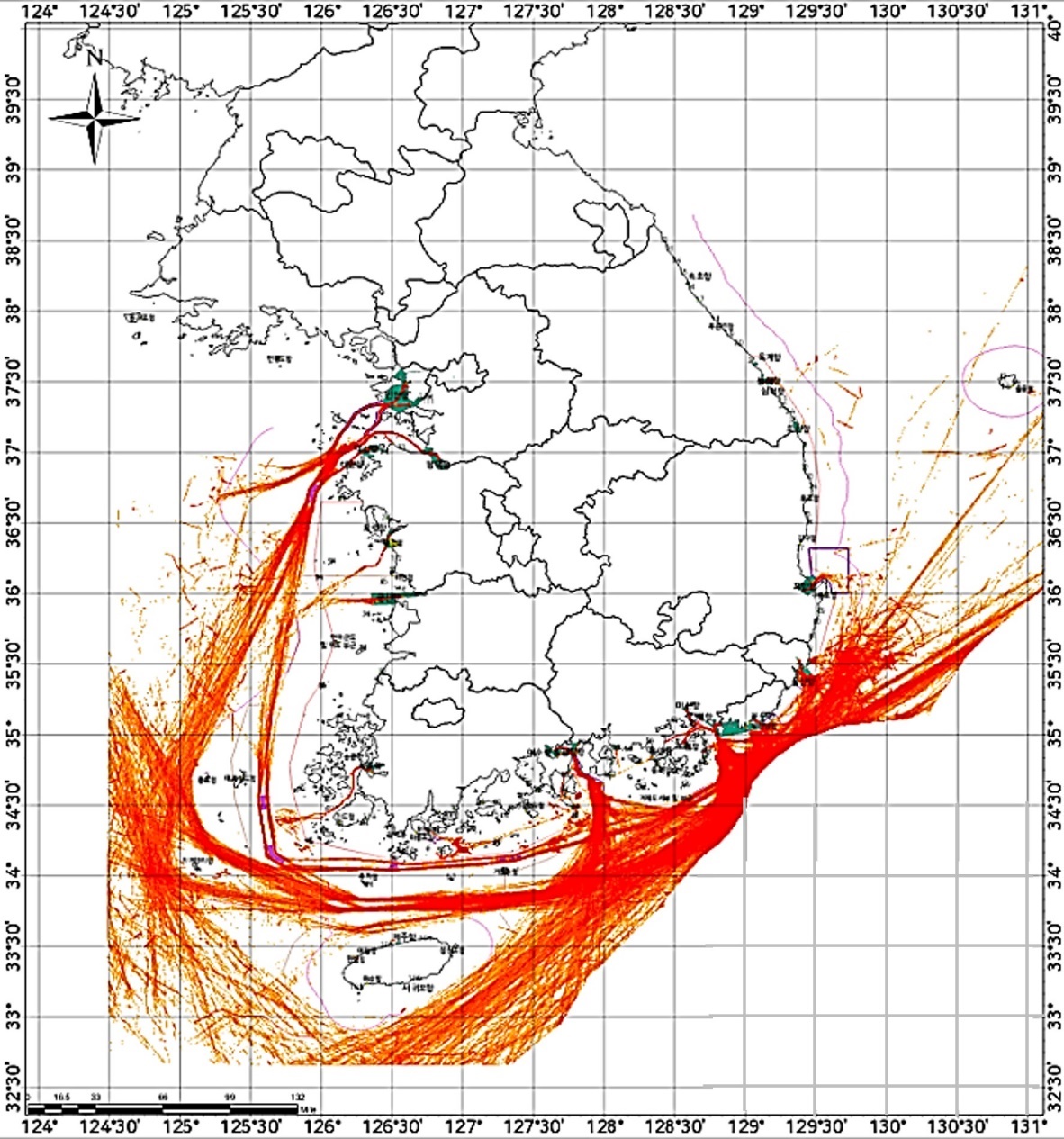
Source: MOF (2023)

The disadvantage is that it takes some time to calculate the density because all ship's navigation records have to calculate the time they stay in the cell. However, if this method is used, the traffic density can be expressed proportionately to the time all ships stay in the cell, so results similar to the traffic density felt by the actual operator can be obtained (Korea Maritime & Ocean University, 2023). In other words, space-time density analysis is a density calculation method that can express the risk of accidents and the degree of difficulty in navigation the operator feels when ma yf ships are concentrated in a certain area. The Korean government considers the space-time density analysis as an appropriate analysis method to express the actual difficulties felt by ship operators.

## 2.2.4 Traffic Density of Cargo Vessels

According to the Space-time density analysis method, the Korean government calculated the ship traffic density for 500,000 (493,370) cells in Korea's coastal waters. The traffic density was calculated based on the navigational information of the AIS which was installed in the ship that navigate the coastal water of ROK. First, the traffic density of the merchant ship is as follows.

Figure 5: Cargo ships traffic density of coastal water of ROK (2020)



Source: MOF (2023)

The color of cells with high passage density is expressed in red, and the color of cells with no or low passage density is expressed in white.

## 2.2.5 Traffic Density of Passenger Ships

Other types of ships with AIS operating in the coastal waters of Korea are passenger ships. Passenger ships operating in the coastal waters of Korea are as follows.

Figure 6: Passenger ships traffic density of coastal water of ROK (2020)

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Source: MOF (2023)

Before operating a passenger ship, the operator must register the operating area with the MOF in advance in accordance with the Shipping Act. Considering the administrative procedures of the passenger ship operation business, passenger ships seem to repeatedly operate in the previously discussed navigation area.

## 2.2.6 Research Gap

The ship's operation information used to calculate the traffic density in the coastal waters of ROK is AIS information (Korean Government, 2023). In other words, it is difficult to use ships' traffic density without AIS to calculate the density required for designating the MTR. Ships that must install AIS in accordance with SOLAS and Korean domestic law are as follows.

Table 4: Domestic Law and International Convention on the Establishment of AIS

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| --- | --- |
| Domestic law (Ship Safety Act) | International Convention (SOLAS) |
| 1. any of the following ships with a total tonnage of 2 tons or more  A. Passenger ships  B. Vessels under the Excursion ship and Ferry business ACT  2. A ship with a total tonnage of 300 tons or more serving international navigation as a ship other than a passenger ship  3. Ship with 500 tons or more not operating in international navigation as a ship other than a passenger ship  4. Towing vessels, tankers, and hazardous cargo ships navigating over the coastal zone of 50 tons or more | 1. All ships of 300 gross tonnage and upwards engaged on international voyages  2. Cargo ships of 500 gross tonnage and upwards not engaged on international voyages  3. Passenger ships |

Source: Author (2024)

After all, AIS is not installed not only for most fishing vessels but also for leisure boats, which are difficult to install due to the structure of the ship. As a result, the navigational information of fishing vessels and leisure boats is not reflected when the traffic density, which is the basic information of the MTR, is calculated.

## 2.3 Case Study on the Designation of Maritime Transport Route

Since October 2008, the Intergovernmental Marine Science Committee under UNESCO has considered introducing Maritime Spatial Planning (MSP) as a management tool for the ocean. In addition, UNESCO has discussed creating guidelines to present a unified concept, principle, and approach to MSPs (UNESCO, 2021). Various countries are developing MSPs considering domestic conditions, and accordingly, the sea areas where ships can navigate are separately identified. In some countries, maritime traffic areas are secured by designating routes. There are various ways to designate and operate routes. While some routes prohibit activities that hinder the safe operation of ships, some do not stipulate restrictive activities on routes. This chapter will review the cases of various countries that have secured maritime transportation areas.

## 2.3.1 Europe

The European Union (EU) has established a Transnational Maritime Space Planning (MSP) to efficiently utilize marine space and avoid conflicts of interest at sea between EU member states. In accordance with the Directive (DIRECTIVE 2014/89/EU), the EU mandates the establishment of MSP but establishes MSP within the scope of not infringing on autonomy, such as sufficiently considering individual laws and institutional characteristics of member states (EU, 2014). In the case of the Baltic countries of Europe, in the process of establishing MSP, the use of each space is set, and the ship's route is designated. In particular, the ship's route is designated as a priority area for shipping. In this area, shipping operations take precedence.

According to the guidelines of the Baltic Sea Marine Spatial Plans, the route is derived in six steps. It analyzes the current status of existing routes and ship flows in the waters where the MSP is to be established and predicts future spatial demand by considering policy, legal, and political factors. In this process, through consultation with stakeholders, the possibility of conflict with purposes other than the route in the relevant sea area is confirmed, and a draft route is finally drawn.

Table 5: A Practical Guide to the Design of Ship Corridors in Maritime Spatial Planning

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| --- | --- | --- |
| 1. Data acquisition of IMO measures in the national sea area |  | 1.1 Transfer of existent IMO routeing and fixed uses as a basis for initial plan drafting  1.2 Assessment of future plans for potential spatial regulation of ship traffic |
| ↓ |  |  |
| 2. Data acquisition and preparation of Automatic Identification System (AIS) data |  | 2.1 Assessment of current ship traffic patterns for a first draft of ship corridor designations 2.2 Consideration of safety issues |
| ↓ |  |  |
| 3. Assessment of political goals and policies that impact the shipping sector |  | 3.1 Assessment of economic development and industrial developments in the shipping sector 3.2 Assessment of changing natural conditions impacting the shipping sector 3.3 Indication of an area with changing spatial needs for shipping in the future |
| ↓ |  |  |
| 4. Assessment of spatial demands across sectors |  | 4.1 Indication of potential conflicts between different uses  4.2 Development of planning solutions |
| ↓ |  |  |
| 5. Assessment of transnational ship traffic |  | 5.1 Analysis of designated ship corridors along borders 5.2 Alignment of ship corridors across borders |
| ↓ |  |  |
| 6. Categorization of areas for shipping |  | 6.1 Designation of shipping corridors |

Source: European MSP Platform (2024)

The following figures show the MSP in Belgium and Germany designated in accordance with the procedure. The shipping sector is one of the most prominent activities within any given maritime space, so it is one of the first sectors considered when drafting MSP (European Commission, 2024).

Figure 7: Maritime Spatial Plan for the German EEZ (2024)

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Source: European Commission, European MSP platform(2024)

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## 2.3.2 Japan

The coastal waters connecting Tokyo Bay, Ise Bay, and the Seto Inland Sea have a high volume of vessel traffic and many complicated route intersections, so serious marine accidents are likely to occur. Therefore, efforts are being made to improve the safety of vessel traffic. Japan government decided to conduct a basic survey of the navigation environment in the model sea area off the west coast of Izu Oshima and to proceed with the study of streamlining measures using AIS data.  The "Research Committee on Establishing Safety Measures in the Waters West of Izu Oshima," which is made up of government, academics, and private sector members and is organized by the Japan Association for Marine Accident Prevention, examined the setting of recommended shipping routes and concluded that they would be effective in reducing the risk of collision (Japan Government, 2018). In November 2016, Japan submitted the first proposal document for setting recommended routes to the IMO. The proposal was adopted at the IMO Maritime Safety Committee held in June 2017, and it was decided that the system would go into effect on January 1, 2018 (Japan government, 2018).

According to IMO MSC/Circ.1060, Member States must clearly state whether routing systems are being proposed as recommendations or obligations when building a routing system for ships (IMO, 2003). Also, IMO defines the recommended route as “a route of undefined width, for the convenience of ships in transit, which is often marked by centreline buoys” (IMO, 2003). Therefore, the recommended route prepared by the Japanese government is not a route that must be observed in terms of operation but a route recommended by the Japanese government, which is indicated in the form of a line, as shown in the figure below.

Figure 8: Recommended Route off the Western Coast of Izu O Shima Island

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Source: Japan Government (2018)

## 2.3.3 China

The "National Maritime Ship Route General Plan" stipulates an arterial route connecting major ports across China and a branch route connecting the arterial route with surrounding coastal ports. The plan designates two-way arterial and branch routes for smooth traffic flow. A total of 78 routes are designated, with 16 two-way arterial routes, 49 two-way branch routes, 10 recommended routes, and three deep-sea routes (China Government, 2011).

Figure 9: Publication of Major Public Navigation Routes in the Bohai Sea

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Source: Shanghai P&I Services (2023)

The Plan is the overall plan for establishing shipping routes along the country’s coast. It is an important supplement to the Overall Plan for Coastal Ship Routing System. “Goals of Ship Route Planning is (i) Plan the overall layout of my country's coastal shipping route system. (ii) Plan the seagoing routes of the major coastal ports and the connecting routes between the ports (III) Ship route planning should be consistent with the implemented ship routing system and the planned ship routing system” (China Government, 2011).

## 2.3.4 Research Gap

According to the IMO Resolution A.572(14), IMO defines the routeing system as “Any system of one or more routes or routeing measures aimed at reducing the risk of casualties; it includes traffic separation schemes, two-way routes, recommended tracks, areas to be avoided, inshore traffic zones, roundabouts, precautionary areas, and deep water routes” (IMO, 1985). IMO defines a total of 14 ship traffic areas (Appendix A), including a routing system, a traffic separation scheme, Roundabout, a recommended route, and a deep water route. “A Government proposing a new routeing system or an amendment to an adopted routeing system, any part of which lies beyond its territorial sea, should consult IMO so that such system may be adopted or amended by IMO for international use” (IMO, 1985).

If so, will the problem that Korean society is currently struggling be solved if only the maritime traffic area defined by the IMO is set up and managed? It is questionable whether the 14 ship passage areas defined by IMO are sufficient to define the characteristics of marine traffic areas in the coastal waters of Korea. The case of the United Kingdom, which had a similar experience to Korea in relation to the development of offshore wind farms about 20 years ago, could answer these questions.

In the UK, prior to the Korean government, discussions took place on the definition of maritime transportation area in relation to the creation of offshore wind farms. In 2004, in the transportation field of the House Standing Committee of the British Parliament, there was a discussion between the National Assembly and the administration on the process of installing offshore wind power generation facilities in the coastal waters of the UK. In this discussion, the relationship between the sea area where offshore wind farms are installed and maritime transportation routes was discussed. The British government's answer is that “There is no formal definition of ‘What is a recognized sea lane for international navigation’” (UK, 2004). Of course, most countries have legal routes in the same waters near ports. However, there seems to be no unified standard for how to protect the areas where ships pass other than legal routes. As a result, in Europe, maritime traffic areas are secured according to MSP, in China, National Maritime Ship Route General Plant, and in Japan, a maritime traffic area with the characteristics of a recommended route is applied. The Korean government has set a plan to designate MTR in coastal waters by 2027 to secure the maritime transport area. MOF is considering enacting a separate law on the designation of MTR. In the case of enacting a law for the designation of sea traffic routes, a legal definition of MTR is basically required.

# Chapter 3 Methodology

Based on the research gap in research promoted for the policy of designating MTR, in this chapter, a methodology will be proposed to study the suitability of MTR based on AIS information and the way the legal and administrative definition of MTR is defined. As previously discussed, in accordance with domestic law and international conventions, most fishing vessels and leisure boats may not install AIS. Therefore, since the MTR policy currently being reviewed by the Korean government is based on AIS information, the operating characteristics of fishing vessels and leisure boats may not be properly reflected. The Korean government intends to ensure the safety of all ships operating in coastal waters, including fishing vessels and leisure boats, through the MTR policy. Therefore, it is important to reflect the operational characteristics of not only ships with AIS installed in the MTR reviewed by the Korean government but also fishing vessels and leisure boats without AIS. In order to examine the suitability of the MTR, the relationship between the MTR coverage based on AIS information and the operating areas of fishing vessels and leisure boats will be compared and analyzed using the methodology shown in Figure. 10 below. In addition, legal analysis of domestic law, laws of other countries, and international regulations to review the legal and administrative definitions of MTR will be conducted in the same way as in Figure 10 below.

Figure 10: Structure of Study

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Source: Author (2024)

## 3.1 Traffic density analysis of Fishing vessels and Leasure boats

In order to analyze the traffic density of coastal waters, the Korean government divided the entire coastal waters into 493,370 cells of 1 km x 1 km, and the traffic density for each cell was calculated by the Space-Time Density analysis method mentioned in Figure 4. Cells with high traffic density were expressed in darker colors, and cells with a traffic density of 0 were expressed in white. Among the cells expressed in this way, the top 40% of cells with high traffic density were selected. The outermost lines of these selected cells were connected and expressed as a spatial concept to establish an MTR. The initial version of MTR prepared by the Korean government's study was reviewed in the following manner.

Figure 11: Initial draft of the Korean Government’s MTR project

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Source: Author (2024)

In Korea, there are three ways to register and inspect ships according to domestic law. In the case of ships that are registered and inspected in accordance with international conventions such as the International Convention for the Safety of Life at Sea (SOLAS), International Convention for the Prevention of Pollution from Ships (MARPOL), and International Convention on Tonnage Measurement of Ships (TONNAGE), registration is proceeded in accordance with the Ship Act, and facilities are installed in accordance with the Ship Safety Act. Separately, fishing vessels are registered and inspected according to the Fishing Vessel Act. Leisure boats are registered and inspected according to the Water Leisure Safety Act. Most of the AIS information used in the traffic density survey reflects the operation data of ships registered by the Ship Act, such as cargo vessels and passenger ships. It is highly likely that only a small part of the operation information of fishing vessels and leisure boats was reflected in the MTR. Therefore, in this study, the level at which the operating areas of fishing vessels and leisure boats without AIS installations are included in the areas of MTR. Through this, the relationship between the operation status of fishing vessels and leisure boats that do not have AIS installed and the traffic density based on AIS data, which is the basis for designating MTR, will be analyzed.

## 3.1.1 Comparative review of where the fishing vessel’s operation records are included in the MTR

In this study, the MTR reflecting the operation records of ships with AIS, such as cargo ships and passenger ships, will be compared with the operation area of fishing vessels. The data from the fishing vessel navigation record equipment managed by the MOF will be used. However, in the case of the Korean government, the operation records of ships are managed as non-public information, so it is possible to check the navigation records only for the period during which the government is disclosing the data and for some fishing vessels. By comparing the drawings of the traffic-dense area, which is based on the AIS data, with the fishing vessel's navigation area, it is intended to determine whether the fishing vessel's navigation is covered by the MTR.

The Korean government has set up an MTR by calculating the traffic density based on the AIS information. However, in the case of fishing vessels, navigation records are managed in a different form from the AIS information, so simple comparison is difficult. Therefore, in order to compare the fishing vessel's navigation record and MTR, it is necessary to calculate the traffic density of the fishing vessel and set up an area with high traffic density in the same form as MTR. By comparing the traffic density area of the fishing vessel with the area being reviewed as MTR, it is possible to check how much the traffic density of the fishing vessel is included in the MTR.

The method of setting the traffic density area of the fishing vessel is intended to follow the procedure described in Figure 9, which is the same method as the MTR setting. Comparative analysis of the two pieces of information will be possible by converting the form of information on the fishing boat's traffic-dense sea area in the same way as MTR. To proceed with this work, the Geographic Information System (GIS) used by the Korean government and related research institutes can be used. Using the GIS system, the area can be specified using latitude and longitude, and the area where the two areas overlap can be calculated. Using these comparison results, it will be possible to determine how much of the fishing vessel’s traffic-dense sea area is included in the MTR area. The MTR includes the traffic-dense area of the fishing vessel, which means that the fishing vessel's operational characteristics are well reflected in the MTR.

The GIS is the same system used by the Korean government when it established the area of the MTR based on the density of ships' traffic. The comparative analysis will be conducted in the following manner, as described in Figure 12. Using this method, it is possible to calculate how much of the navigational area the fishing vessels contain in the MTR.

Figure 12: Example of the Comparison Method of MTR and Fishing vessel Navigation Area Using GIS System

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Source: Author (2024)

## 3.1.2 Comparative review of where the leisure boat’s operation records are included in the MTR

In order to create a safe marine leisure environment, the Korean government is creating a marina port that leisure boats can use exclusively with the national budget. By 2030, six large marina ports will be established in the coastal waters of Korea. In the case of leisure boats, AIS is not installed in accordance with ROK regulations. However, the departure and destination information of leisure boats are reported to the internal system of the MOF when departing.

Leisure boats, such as yachts, which sail by wind power, cannot be equipped with electronic equipment such as GPS due to the structural characteristics of the boat. Therefore, it is very difficult to identify the coastal water in which leisure boats are actually navigated. However, in 2016, the National Oceanic and Atmospheric Research Service, an agency affiliated with the MOF, published a ‘Map of Yacht Sailing Route’ to support the safe operation of leisure. The Map of Yacht Sailing Route was prepared through expert reviews, field surveys, and review of local government data, and the routes mainly navigated by leisure boats were shown on the chart as a line (National Oceanic and Atmospheric Research Service, 2016). Therefore, the ‘Map of Yacht Sailing Route’ contains not only the opinions of the Korean people using leisure boats but also information on the actual operating characteristics of leisure boats, as well as the routes on which leisure boats can operate safely. Like the course line used for navigation by ordinary ships, the ‘Map of Yacht Sailing Route’ consists of a line connecting waypoints using latitude and longitude. It is possible to check the route that leisure boats mainly sail through the Map of Yacht Sailing Route. The comparative analysis will be conducted in the following manner. By comparing the drawings of the MTR with the ‘Map of Yacht Sailing Route’, it is possible to check how much the navigation route (line) mainly used by leisure boats is included in the MTR.

Figure 13: Example of the Comparison Method of MTR and Leisure boat main course line Using GIS System

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Source: Author (2024)

## 3.2 Legal Framework review of MTR definition

All ships have the freedom to navigate in accordance with the United Nations Convention on the Law of the Sea (UNCLOS). However, shipping routes or fairways are designated in accordance with domestic laws and international conventions, especially at port entrances or traffic separate schemes, etc. In these shipping routes or fairways, fishing and marine leisure activities shall not impede the passage of a vessel that can safely navigate only within a narrow channel or fairway in accordance with domestic law (Maritime Traffic Safety Act Rule 33) or international conventions (COLREG Rule 9) for the safe passage of ships navigating along the route. Therefore, the Korean government compensates stakeholders such as fishermen when designing shipping routes or fairways. In the case of MTR, marine transportation areas will be established in all coastal waters of Korea. If the policy is promoted in the same way as the existing route, in a way that restricts fishing activities within MTR, compensation will have to be paid to numerous stakeholders, which will bear a budget that the government cannot afford. Therefore, the Korean government should pursue the MTR policy in a way that secures maritime transportation area without restricting the activities of existing stakeholders. The MTR will be operated as a ship traffic route in a different sense from the existing shipping route. The MOF also plans to designate a separate MTR management agency when designating an MTR and remove risk factors that hinder ship passage safety, such as removing obstacles and managing water leisure activities and marine development activities. In order to designate and manage MTR, additional budgets must be secured. All administrative actions, including budget execution by the Korean government, are based on the law. However, there is no law related to MTR. The Korean government is considering enacting new laws to promote policies on the designation and management of MTR. Policies not based on the law have side effects, such as causing unnecessary social confusion. Therefore, in this report, the definition of MTR, taken into consideration the government's MTR designation and operation plan, will be reviewed.

## 3.2.1 Domestic law

Since the Act related on MTR will be a domestic law of the ROK, similar concepts and precedents in relation to the MTR that the MOF is trying to promote in the domestic legal system will be analyzed.

In addition, when a new law is enacted, it must be reviewed by the Ministry of Legislation and the National Assembly, and in this process, whether there are similar cases in other laws must be presented. The figure below shows the process of enacting laws in the Korean government and the National Assembly.

Figure 14: Domestic Legislative Process

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| --- |
| Legislative Process |

Source: MOF (2022)

Other laws that define traffic areas similar to MTR will be reviewed through a legal analysis of domestic laws in Korea. Through this legal analysis, elements that can benchmark the legal definition of MTR will be discovered.

## 3.2.2 Laws of Other Countries

Most coastal countries designate coastal waters where ships can navigate in waters near ports or waters with complex maritime traffic. There are various ways of operating these waters. Some activities that can hinder the safe navigation of ships, such as fishing and marine leisure activities, are restricted in areas such as legal routes, while the government only suggests recommended routes and does not impose any restrictions on them in waters such as recommended routes. The ways to secure marine transportation areas used in various countries will be reviewed. For this review, the establishment and operation methods of major sea areas that play an important role in international shipping logistics can be reviewed. In addition, by reviewing the cases of other countries that have already implemented policies to secure maritime transportation areas, it will be possible to clarify the definition of MTR and minimize errors that may occur at the beginning of the policy.

## 3.2.3 International regulations

The traffic routes of coastal countries are designated and managed by domestic law. However, since the route is an area used not only by domestic ships but also by foreign ships, the basic direction of route setting and management is stipulated in international conventions such as SOLAS. In addition, even when a marine structure such as an offshore wind farm is constructed, a ship’s navigation area must be established near the structure in order to prevent collisions with nearby passing ships in accordance with international regulations. The MTR promoted by the Korean government will be designated and managed in accordance with Korean domestic law. However, the MTR should meet international standards as much as possible in order for all ships, as well as Korean flag ships, to use it safely. By examining the international standards for designating a navigation area, it will be possible to create a maritime traffic area where all ships can safely navigate.

# Chapter 4 Results

Using the methodology described in Chapter 3, this chapter will compare the operating areas of fishing vessels and leisure boats without AIS to MTR and review domestic laws, laws of other countries, and international regulations dealing with MTR-like systems to examine the legal and administrative definition of MTR. If a number of operating areas of fishing vessels and leisure boats are included in the MTR range, the justification of the MTR policy will be strengthened. Otherwise, it will be necessary to review the MTR settings. In addition, from the perspective of reviewing the definition of MTR, regulations on the definition of ship traffic areas similar to MTR under domestic law, laws of other countries, and international regulations could be used to establish the definition of MTR.

## 4.1 Result of Comparative Analysis of the MTR and the Operating Area of Ships without AIS

In Korea, there are 61 ports primarily used by cargo ships or passenger ships, whereas there are 1,036 fishing ports used by fishing vessels and 37 marina ports used by leisure boats (Korean Government, 2023). Additional port facilities are required for the transportation of cargo and passengers, and the approximate route is determined in advance when registering the transport business, so the route of cargo and passenger ships is standardized to some extent. However, in the case of fishing vessels and leisure boats, various methods of operation may appear depending on the purpose of the operator, such as fishing and tourism. The navigation routes of these fishing vessels and leisure vessels vary widely with time and season.

## 4.1.1 Comparative Analysis of Fishing Vessels’ Operating Area and MTR

Fishing vessels operate between fishing ports and fishing ports or between fishing ports and fishing grounds. In addition, the number of ports in which fishing vessels enter and exit is about 20 times the number of ports used by cargo ships and passenger ships. The characteristics of the place where the fishing vessel enters and exits and the purpose of the fishing vessel's navigation are different. Therefore, it is highly likely that the operation records of cargo ships and passenger ships installing AIS and the operation records of fishing vessels are different. As a result, other types of operations are bound to take place as follows. Depending on the fishing industry type, fishing vessels' operating records are very different. The Korean government analyzed fishing vessel operation records for a total of 28 days, from March 1 to 7, 2021, June 1 to 7, September 1 to 7, and December 1 to 7, 2021, to understand the operation characteristics of fishing vessels. The data used to analyze the operation records of fishing vessels is information from V-PASS, a navigation record device separately installed on fishing vessels according to the Korean Fishing Vessel Act. The navigation records of fishing vessels during the period are shown in the following figure.

Figure 15: Fishing vessels' navigational record

|  |  |
| --- | --- |
|  |  |
| Coastal stow nets on anchor-type fishing vessels (2021) | Coastal purse seine-type fishing vessel (2021) |

Source: MOF (2023)

The type of operation of the fishing vessels varies depending on the type of fishing and the target fish. Therefore, this chapter intends to calculate the traffic density of fishing vessels using the traffic records of all kinds of fishing vessels that the MOF can provide. Of course, the ideal result can be derived by analyzing the fishing vessel's navigation records over a long period. However, the fishing vessel's operation information is managed as non-public information. Therefore, the purpose of this study is to analyze the areas with high traffic density, targeting only the operational information of fishing vessels that can be verified. The fishing vessel's navigation information used in this study is the navigation record of fishing vessels operating in the West Coast waters of Korea from January 17 to 19, 2021. According to the ‘Rules for Fishing Vessels to Operate Safely’ implemented in 2017, January is the time when many fish, such as skate, are caught on the West Coast, and many fishing vessels are actively engaged in fishing (MOF, 2017). Therefore, January is a time when a large number of fishing vessels are likely to operate. It seems to be a time to reflect on the operating characteristics of many fishing vessels. During a specific period (January 17-19, 2021), the fishing vessel operation records on the west coast (the sea near Taenan and Byeonsan) of Korea were analyzed as follows.

Figure 16: Traffic density of Fishing vessels in the west coastal water of Korea

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| --- |
|  |

Source: Author (2024)

The following water area can be derived by calculating the traffic density for each area (cell) in the same way as the MTR was reviewed (Figure 11).

Figure 17: Fishing vessel Traffic dense area and MTR on the west coast of ROK

|  |  |
| --- | --- |
|  |  |
| Fishing vessel traffic dense area | MTR |

Source: Author (2024)

Using the GIS system used by the Korean government when conducting MTR-related research, the area of the fishing vessel's traffic-dense area was calculated to be about 452.91 km2. The MTR set in the same water area (Sea near Taean and Byeonsan) for comparison with the fishing vessel's traffic-dense area is as follows.

The 'pairwise clip' function of the GIS system was used to compare the fishing vessel's traffic-dense area with the MTR reviewed by the MOF. The 'pairwise clip' is a tool that separates and specifies parts of one drawing that overlap with other drawings. When using the pairwise clip function, not only can the overlapping area of the fishing vessel's traffic-dense area be separately distinguished, but the size of the overlapping area can also be calculated. Therefore, when using this function, it is possible to check how much of the MTR overlaps with the traffic-dense area of the fishing vessels. The pairwise clip function in the GIS system works in the same way as shown in the following figure.

Figure 18: Pairwise Crip

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| --- |
|  |

Source: Author (2024)

The results of overlapping with MTR (Figure 18), which is formed in the same area as the fishing vessel's traffic-dense area (Figure 17), are shown in the figure below.

Figure 19: Comparison of MTR with high traffic dense area of fishing vessels

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|  |

Source: Author (2024)

The pairwise clip function was used to separate the area where the two drawings were overlapped, and then the result of measuring the area was calculated as 36.26 km2. Considering that the total area of the fishing vessel’s traffic-dense area is 425.91 km2, the fishing vessel's traffic-dense area overlapping the MTR (36.26 km2) is 8% of the area of the total fishing vessel’s traffic-dense area in certain waters off the west coast of Korea.

## 4.1.2 Comparative Analysis of Leasure Boats’ Operating Area and MTR

There are 37 marina ports in operation in Korea, and 2,403 berths are provided exclusively for leisure boats. In the case of leisure boats, the ports of entry and exit are determined. However, the destination is determined differently according to the taste of leisure boat operators, such as islands, fishing spots, scuba diving points, etc. These operating characteristics are a major factor that makes it difficult to analyze the operating records of leisure boats.

However, for two years, in 2016 and 2021, the Korean government announced ‘Map of Yacht Sailing Route’ through research that included analysis of experts in the marine leisure field, collecting user opinions, a written survey of local governments, and field surveys. The ‘Map of Yacht Sailing Route’ was created by the Korean government to support the safe navigation of the Korean people who enjoy marine leisure navigation. It consists of a course line using latitude and longitude to make it easier for leisure boat operators to identify safe navigation routes. Therefore, the course line of leisure boats, according to the 'Map of Yacht Sailing Route', can be seen as being practically used by many leisure boat operators. In this study, the course line of ‘Map of Yacht Sailing Route’ will be overlapped with the MTR to analyze the relationship between the operating area of leisure boats and the MTR.

The ideal way to check the current status of the course line of leisure boats included in the MTR is to overlap and compare the course line of leisure boats established in all coastal waters of Korea. However, in the case of fishing vessels, the available fishing vessel operation information was limited to the west coast of Korea. In addition, in order to overlap the MTR with the 'Map of Yacht Sailing Route,' the course line must be extracted from the 'Map of Yacht Sailing Route' and implanted into the MTR research system. However, because the spatial information form of the 'Map of Yacht Sailing Route' and the spatial information form of MTR are different, it is very difficult to completely transplant the course line information of the 'Map of Yacht Sailing Route' into the MTR research system. Therefore, by extracting the course line of the Map of Yacht Sailing Route and comparing it with the MTR only in the west coast area, which is the same area as the area where the fishing vessels's operation information was analyzed, the status of overlapping the operating area of the fishing vessels and leisure boats and MTR will be identified with the same standard of area.

The following figure shows the relationship between the course line of the Map of Yacht Sailing Route and the MTR formed on the west coast of Korea.

Figure 20: Comparison of MTR with the Map of Yacht Sailing Route

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| --- |
|  |

Source: Author (2024)

In the water area corresponding to the above figure, the length of the course line of the leisure boat corresponding to the 'Map of Yacht Sailing Route' is a total of 238 km, and the area marked with a red circle is the area where the course line of the leisure boat and the MTR overlap. The enlarged red circle is shown in the following figure.

Figure 21: MTR and 'Map of Yacht Sailing Route' overlap waters

|  |  |
| --- | --- |
|  |  |

Source: Author (2024)

The course line of the Yacht Sailing Route included in the MTR is 6,410 meters long, so about 2.7% of the yacht routes are included in the MTR.

## 4.2 Analysis of the definition of ship operating area for the preparation of legal and administrative definitions for MTR

The Korean government is setting three principles in promoting the MTR policy as follows:

(a) Waters with high traffic density

An area with high ship traffic is designated as MTR. To this end, the traffic density of 500,000 (493,370) cells in all coastal waters of Korea was calculated based on the ship's AIS information. However, there seems to be no specific criterion for the level of traffic density for designating as MTR, such as whether to select the cell of the top 40% or the cell of the top 20% of the traffic density.

(b) Waters that do not restrict existing activities

It does not restrict the activities of existing stakeholders, such as fishing activities in the sea area set as MTR. Of course, it can be said that it is best to limit activities that affect the safety of ships, such as fishing activities and leisure activities, in terms of ship safety within the traffic-dense area, but this violates the rights of existing stakeholders and can eventually lead to compensation issues. Considering the scope of MTR, this will be a problem of compensation at a level that the Korean government cannot afford.

(c) Waters divided into areas

MTR plans to set it as an area. Some operating areas, such as recommended routes, are only defined as a line separating the passage, but this does not conform to the first principle, which is the basic policy of preserving areas with high traffic density. When reviewing domestic laws, laws of other countries, and international conventions based on these three principles, the characteristics of the vessel traffic area as viewed in each regulation will be analyzed.

## 4.2.1 Domestic law

In order to secure marine traffic areas necessary for vessel traffic safety, the Korean government operates a system for designating Routes, Traffic Separation Scheme (TSS), and Special Areas of Traffic Safety in accordance with the Maritime Traffic Safety Act. In these waters, ship passage is given priority. If activities such as fishing, marine development, and marine leisure that can hinder traffic safety are prohibited or necessary, permission from the local maritime and fisheries offices and the Coast Guard must be obtained in advance.

According to Article 30 of the Maritime Traffic Safety Act (designation of routes, etc.), the Minister of Oceans and Fisheries may designate routes in waters where there is a high risk of accidents and operate systems necessary for navigation safety such as speed limits. Twenty-eight routes are designated in coastal waters of Korea as follows.

Table 6: Comparison of MTR with the Map of Yacht Sailing Route

|  |  |  |
| --- | --- | --- |
| No. | Name of the Route | Speed limit |
| 1 | Gaduksudo Route (Port entry route) | ○ |
| 2 | Janganseo Incheon port entry route | X |
| 3 | Jungsoo-do Route | X |
| 4 | Pung-do Recommend Route | X |
| 5 | Janganseo Pyeongteak port Route | X |
| 6 | Ong-do Route | X |
| 7 | Mokpogu/Siahe/Jungdeunghe Route | ○ |
| 8 | Myeongnyangsudol Route | ○ |
| 9 | Deep Sea route | X |
| 10 | North Maemulsudo Route | X |
| 11 | South Maemulsudo Route | X |
| 12 | Hongdo No.1 Route | X |
| 13 | Hongdo No.2 Route | X |
| 14 | Heuksan Route | X |
| 15 | Heuksan/Hongdo Route | X |
| 16 | Wando Port entry and crossing Route | X |
| 17 | Hwenggansudo Route | X |
| 18 | Sodukwoodo Route | X |
| 19 | Masan Route | ○ |
| 20 | Jinhae Route | ○ |
| 21 | Gohyen Route | ○ |
| 22 | Wonjeon Route | ○ |
| 23 | Anjung Route | ○ |
| 24 | Jangja Route | X |
| 25 | Naesan Route | X |
| 26 | Geoje-Dumido naehesudo Route | `X |
| 27 | Samcheonpo Port Recommend Route | X |
| 28 | Homigot Recommend Route | X |

Source : MOF (2023)

In accordance with Article 33 of the Maritime Traffic Safety Act (preservation of routes, etc.), neglect of ships, fishing activities, and marine leisure activities are restricted on the route. In addition, under Article 34 of the Maritime Traffic Safety Act (Securing the Safety of Waters, etc.), no one can interfere with the passage of ships by occupying or blocking the route.

Another system in which the Korean government establishes a navigation area for ships is ‘Special Areas for Traffic Safety.’ There are five ‘Special Areas for Traffic Safety’ as follows.

Table 7: Current Status of Korea’s Special Areas for Traffic Safety

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| No | Zone | Area(km2) | Length(mile) | Width(mile) |
| 1 | Incheon | 137.3 | East bound: 19 West bound: 22 | 1 |
| 2 | Busan | 21.5 | 12 | 6 |
| 3 | Yeosu | 130.2 | 18 | 1~4 |
| 4 | Ulsan | 298 | 12 | 11 |
| 5 | Pohang | 709 | 35 | 24 |

Source: MOF (2023)

In the case of ‘Special Areas for Traffic Safety,’ under Article 7 of the Maritime Traffic Safety Act (establishment of Maritime Traffic Safety Act), areas with a large amount of maritime traffic, such as large ships, dangerous cargo carriers, and high-speed passenger ships shall be designated as a ‘Special Areas for Traffic Safety’. According to Article 12 of the Traffic Safety Act (restrictions on fishing, etc.), ships engaged in fishing operations shall not interfere with the passage of other ships navigating in the Special Areas for Traffic Safety, and fishing nets or other fishing gear that affect the passage of ships shall not be installed.

In accordance with Article 75 of the Maritime Traffic Safety Act (Traffic Separate Schemes), there are three Traffic Separate Schemes (TSS) on the coast of Korea that need to apply the transit separation system due to the high amount of maritime traffic and the risk of collisions. According to the Maritime Traffic Safety Act and International Convention (COLREG), special rules are applied in the TSS, such as navigation in a set direction, navigation away from the separation line, and access through the entrance of the passage route.

Table 8: Current Status of Korea’s TSS

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| No | Zone | Area(km2) | Length(Km) | Width(km) |
| 1 | Bogildo TSS | 58.45 | Eastbound: 7.64 Westbound: 5.66 | 2.94~905 |
| 2 | Geomumdo TSS | 110.66 | Eastbound: 17.37 Westbound: 17.64 | 2.6~6.3 |
| 3 | Hondgo TSS | 80.66 | Eastbound: 9.27 Westbound: 9.27 | 4.0~8.67 |

Source: MOF (2023)

## 4.2.2 Laws of other countries

In this chapter, three important maritime transportation area management systems for international shipping logistics will be reviewed. First, the composition and operation method of the English Channel, including Dover Street, will be studied. “The English Channel (EC), called ‘La Manche’ in French, is a sea shared between the United Kingdom and France. It is largely open in its western boundary to Atlantic influence and is connected with the North Sea by the Dover Strait (30 km wide) and extends for about 750 km along its WSW–ENE axis, giving an overall area of 77,000 km2” (Charles, 2019). The EC consists of TSS, Inshore Traffic Zones, Area to be Avoided, Deep Water Route, etc., and the overall configuration of the channel is as follows.

Figure 22: Composition of the English Channel

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|  |

Source: UK Hydrographic Office (2024)

Dover Street is a TSS adopted by IMO, and ship passage monitoring is conducted by 24-hour VTS. “All vessels over 300 gross tonnes must take part in the scheme. The service area covers a 65-mile stretch of the Dover Strait/Pas-de-Calais” (UK Government, 2024). The Dover Strait is a mandatory reporting area. This means that vessels over 300 gross tonnes must report to either Dover MRCC (South West Lane) or CROSS Gris Nez (North East Lane) before proceeding through the service area (UK Government, 2024). Within the TSS, navigation rules according to COLREG is applied. If the suspicious activity of the ship is detected on Dover Street, the British government may take reasonable action, including investigation.

Next, the composition and operation of the Gibraltar Strait will be reviewed. The Gibraltar Strait is an important sea connecting the Atlantic Ocean and the Mediterranean Sea and is one of the most important straits in terms of shipping and logistics around the world. Like Dover Strait, it is a TSS adopted by IMO (IMO, 1996). The composition of Gibraltar Street is as follows.

Figure 23: Composition of the Gibraltar Strait

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| --- |
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Source: Cruisers forum (2011)

The operator of vessels passing through Gibraltar Strait shall notify the VTS of information such as the ship's name, the ship's course, and speed. The system, manned by the Gibraltar Port Authority´s team of VTS staff, has been operational since 2011 and allows for constant monitoring of all vessel movements” (Gibraltar Port Authority, 2024). Like Dover Street, international conventions on navigation and ship operation, such as SOLAS and COLREG, apply within Gibraltar Strait.

Finally, the management system of the Strait of Malacca will be reviewed. For hundreds of years, the Strait of Malacca has served as a major sea route linking the Pacific Ocean to the Indian Ocean. “Since the rise of India and China as world economic powers the Straits have gained in maritime importance” (Evers, 2011). Malaca Strait runs between the Indonesian island of Sumatra to the west and peninsular (West) Malaysia and extreme southern Thailand to the east and has an area of about 25,000 square miles (65,000 km2). The Straits of Malaca consists of nine sectors, and the composition of the Straits of Malaca is as follows:

Figure 24: Composition of the Strait of Malaca

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| --- |
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Source: MPA Singapore (2024)

In the case of the Straits of Malaca, it is a TSS adopted by IMO, and vessels passing through each sector must report relevant information, such as the location of the ship and the speed of the ship, to the relevant VTS in the following manner.

Table 9: Composition of the Gibraltar Strait

|  |  |  |
| --- | --- | --- |
| SECTOR | VHF CHANNELS | VTS AUTHORITIES |
| Sector 1 | VHF Channel 66 | KLANG VTS |
| Sector 2 | VHF Channel 88 | KLANG VTS |
| Sector 3 | VHF Channel 84 | KLANG VTS |
| Sector 4 | VHF Channel 61 | KLANG VTS |
| Sector 5 | VHF Channel 88 | KLANG VTS |
| Sector 6 | VHF Channel 88 | JOHOR VTS |
| Sector 7 | VHF Channel 73 | SINGAPORE VTS |
| Sector 8 | VHF Channel 14 | SINGAPORE VTS |
| Sector 9 | VHF Channel 10 | SINGAPORE VTS |

Source: MPA Singapore (2024)

In the Straits of Malta, of course, the International Convention on Navigation, COLREG, applies. In addition, vessels navigating in the Straits of Malacca are required to follow the ‘Rules For Vessels Navigating Through the Straits of Malacca and Singapore’ adopted by the IMO Maritime Safety Committee 69 in 1998, in accordance with the provision of Resolution A.858(20) (IMO, 2020). According to Rules For Vessels Navigating Through the Straits of Malacca and Singapore, all ships using the Straits of Malacca must navigate in accordance with the TSS's general traffic flow.

## 4.2.3 International Regulations

The basic international standard regarding the setting of the route used by ships is SOLAS. According to the SOLAS Chapters 5 and 10 rules, ships' routeing systems contribute to the safety of life at sea, the safety and efficiency of navigation, and/or the protection of the marine environment. Ships' routeing systems are recommended for use by, and may be made mandatory for, all ships, certain categories of ships or ships carrying certain cargoes (IMO, 2002). Resolution A.572(14), adopted on 20 November 1985, defines 14 types of ship routes (Appendix A), such as TSS and Precautionary areas. The government must decide whether to enforce compliance with the route system or manage the route system at the recommended level when setting the route (IMO, 2003).

Figure 25: Sample of Routeing system (TSS, Precautionary areas)

|  |  |
| --- | --- |
|  |  |
| TSS | Precautionary areas |

Source: IMO (1985)

When installing offshore facilities such as offshore wind farms, there are standards from private organizations that recommend designating the ships' routeing systems to ensure the safe navigation of existing ships. These standards are not those recognized by the governments or Inter-Governmental Organizations (IGO) such as the IMO but are recommended by private industry. Even if it is the standard of some private organizations, there are cases where the government accepts it as national law. In 2022, the Korean government accepted the standards of the 'World Association for Waterborne Transport Infrastructure' as a national law (Guidelines for Implementation of Marine Traffic Safety Diagnostics) (Korean Government, 2022). If an offshore wind farm is created in the coastal waters of Korea, a route through which ships can pass around the offshore wind farm should be established in accordance with the criteria of the ‘World Association for Waterborne Transport Infrastructure.’ According to the standards, a safe area of at least 0.5 miles (926m) from the offshore wind farm must be established when creating an offshore wind farm, and when there is an offshore wind farm on the right side of the ship passage, a spare water area of 1,055m must be established in addition to 6 times the maximum length of the ship passing through the relevant water area. In addition, when there is an offshore wind farm on the left side of the ship passage, a spare water area of 500m must be established in addition to 6 times the maximum length of the ship passing through the relevant water area. These ship operating areas may be organized as follows.

Figure 26: Required area between shipping route and a starboard side wind farm

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|  |

Source: World Association for Water borne Transport Infrastructure (2018)

Figure 27: Required area between shipping route and a port side wind farm

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| --- |
|  |

Source: World Association for Waterborne Transport Infrastructure (2018)

Companies that manage offshore wind farms must establish a separate safety management system such as VTS. Such a system is a private company's system, and it is not a mandatory regulation that ships must comply with but a measure at the level of recommendation.

# Chapter 5 Discussion

## 5.1 Comparative Analysis of the MTR and the Operating Area of Ships without AIS

The Korean government intends to designate MTR in the coastal waters of Korea to respond to the creation of offshore wind farms and the spread of marine leisure culture and to prepare for the introduction of MASS. The ship's traffic density is key information used when reviewing the MTR, and the ship's operation record used when calculating the ship's traffic density is AIS information. The purpose of this study is to analyze whether the operation status of fishing vessels and leisure boats without AIS is included in the MTR. According to the methodology described in Chapter 3, it was confirmed that only 8% of the fishing vessels' traffic-dense waters (36.25 km2 out of 452.91 km2) were included in the MTR, and only 2.7% (6,410 m out of 238 km) of the major routes of leisure boats were included in the MTR. There seems to be no clear standard for what percentage of the operating area of fishing vessels and leisure boats should be included in the MTR.

MTR is a policy to secure a safe passage area for not only cargo ships and passenger ships with AIS but also fishing vessels and leisure boats without AIS. However, if only 8% of the operating characteristics of fishing vessels and 2.7% of the operating characteristics of leisure boats are reflected in the MTR policy, it is difficult to say that it meets the basic direction of the MTR policy of securing areas for all ships to navigate safely. Therefore, improvement measures such as resetting the MTR are needed so that the operational characteristics of fishing vessels and leisure boats can be more reflected. To this end, in the step of analyzing the ship traffic density required for the MTR setting, improvement measures may be to reflect not only the ships with AIS installed but also the operational characteristics of ships without AIS, such as fishing boats and leisure ships.

## 5.2 Analysis of the Legal and administrative definitions of MTR

ROK is a rule of law, and the government's policies are based on laws and regulations. If governments want to designate MTR, they need laws related to them. When enacting laws related to MTR, it is necessary to clarify the legal and administrative definition of MTR. One of the important processes in the legislative process is deliberation by the Ministry of Legislation and the National Assembly, and the relationship with other existing laws will be examined during the deliberation process. In this process, if there is a conflict with the existing law or if content different from the system of the existing law is found, the legal enactment process becomes very complicated. Therefore, if the definition of terms used by other laws can be utilized, it can be a good way to minimize unnecessary debates in the deliberation process. Therefore, in this chapter, in addition to the contents of the maritime traffic area reviewed in Chapter 4, the definition of MTR will be reviewed by utilizing the existing legal terms used by the Korean government. In addition, MTR will use not only national ships but also foreign ships. Therefore, the definition of MTR will be reviewed along with the laws of other countries and international regulations studied in Chapter 4.

In order to review the legal and administrative definition of MTR, it is necessary to understand the nature of MTR that the Korean government is thinking about. As mentioned in Chapter 4, the Korean government considers the following three characteristics of MTR.

(a) Waters with high traffic density

(b) Waters that do not restrict existing activities

(c) Waters divided into area

(a) Claus is about the nature of the MTR. MTR is an area with a high density of ships passing through, not an area designated by the government or international organizations, but an area formed naturally. The high traffic density of ships means that it is a route frequently used by numerous ship operators. “The quality of the route is related to the navigation safety and economic benefits of ships” (He et al, 2019). In conclusion, MTR is not an area artificially formed by the government or international organizations but an area created spontaneously or by social and economic needs. This can be described as a water area with high traffic density formed naturally or by social and economic needs.

Among Korean laws, the definition of terms suitable for the nature of these MTR can be found in 'Special Act on the Development of Traditional Markets and Shopping Districts'. According to Article 2 (1) of the Special Act on the Development of Traditional Markets and Shopping Districts, the traditional market is defined as ‘The term "traditional market" means a place created spontaneously or according to socioeconomic needs in which commodities or services are traded mainly in traditional-methods based on mutual trust’. Looking at the definition of traditional market in detail, the word 'traditional market' is a combination of two words, 'traditional' and 'market.' Therefore, in the legal definition of a traditional market, 'a place created spontaneously or according to socioeconomic needs' in the front part means the way the traditional market is formed, and 'in which communications or services are the traditional methods based on mutual trust' in the back part means the way of transactions taking place in the traditional market. The formation method of the traditional market seems to be similar to that of the MTR. Therefore, the legal term, 'a place created spontaneously or according to socioeconomic needs', which expresses the formation method of the traditional market, also seems to be used in the legal term for defining MTR.

Since the ROK is a rule of law, the government's regulations restricting the rights of the people must be based on the law. (b) Claus means that the rights of the people are not restricted, which can be satisfied by not having regulations restricting the rights of the people in the law. Shipping Route (Table 6), Special Areas for Traffic Safety (Table 7), and TSS (Table 8), which were examined in Chapter 4, are waters subject to restrictions such as navigation under the Maritime Traffic Safety Act and international regulations. In addition, in waters such as the English Channel (Figure 23), Gibraltar Strait (Figure 24), and Strait of Malaca (Figure 25), restrictions such as navigation under international regulations and the reporting system under the laws of the country concerned are applied. However, in the case of recommended routes operated in Japan, which were examined in Chapter 3, no restrictions are applied to passing ships. In terms of not restricting the passage of ships, recommended routes have characteristics similar to those of MTR.

With respect to the criteria under (c) Claus, the MTR must be specified as an area in order to meet the criteria. If MTR is designated as a constant body of water using latitude and longitude, such as Shipping Route (Table 6), Special Areas for Traffic Safety (Table 7), TSS (Table 8), English Channel (Figure 23), Gibraltar Strait (Figure 24) and Strait of Malaca (Figure 25), the criteria in paragraph (c) can be met. These navigation areas are specified by points and lines separated by latitude and longitude. Therefore, the MTR should also be designated as a specific area using points and lines composed of latitude and longitude. What needs further review is the question of who is the subject of the designation of MTR. According to the Maritime Traffic Safety Act, maritime traffic areas such as Shipping Route (Table 6), Special Areas for Traffic Safety (Table 7), and TSS (Table 8) are designated by the Minister of MOF. The Ministry of Oceans and Fisheries is the central ministry in charge of overall maritime affairs among the administration of the Republic of Korea, and MTR, like shipping routes, is a body of water where ships navigate, so it seems reasonable to designate it by the Minister of Oceans and Fisheries.

In conclusion, considering the characteristics of MTR being reviewed by the Korean government, it can be defined as "a range of bodies of water designated by the Minister of Oceans and Fisheries that is formed spontaneously or according to socioeconomic needs." The three requirements can also be met by not stipulating restrictions in the legislation.

## 5.3 Limitation

The direction of the MTR policy was examined in this study from two perspectives. The first was to examine whether the MTR reflected the operational characteristics of various ships, including fishing vessels and leisure boats, and the second was to examine the legal and administrative definitions of MTR. First, the MTR is based on the information on the traffic density of ships. Therefore, it was necessary to check the operation information of not only cargo ships and passenger ships but also fishing vessels and leisure boats in order to check whether the MTR was properly set. However, since most of the operation information of ships, such as fishing boats, is not disclosed, the study was conducted only with some published information. As a result, the study was conducted based on the records of ship operation for 3 days (January 17 to 19, 2021) in some waters off the west coast of Korea. In conclusion, there were time and area limitations in studying the operation information of the ship.

Next, the legal and administrative definitions of MTR will be used to enact new MTR-related laws in the future. Therefore, in this study, there was a limit to reviewing the definition of MTR in consideration of the actual process of enacting laws in Korea. It was a method of examining how other laws define similar areas, such as MTR, and reviewing the definition of MTR in a similar way. This is because, in the actual legislation process, how the newly enacted law relates to other existing laws is one of the important issues.

# Chapter 6 Conclusion

According to Section 3, Article 17 of the UNCLOS, "ships of all states, where the coast or land-locked, enjoy the right of inhospitable passage through the terrestrial sea" (UN, 1982). However, recent changes in the coastal waters of Korea are causing changes in the environment in which ships can safely navigate in the coastal waters of Korea. The offshore wind farms created in coastal waters have a negative impact on the safe passage of ships, with the creation of offshore wind farms at the entrance of Busan Port, the largest port in Korea. As the Korean people's interest in marine leisure increases, the number of people who directly own and operate yachts and motorboats is increasing, and as the introduction of autonomous ships is promoted, a special law for designating the area for autonomous ships has been newly enacted. In order to respond to changes in the ship operating environment in coastal waters, the Korean government intends to secure a safe area for ships to navigate by designating MTR with a high density of ships. However, it was unclear whether the MTR policy reflected the operating characteristics of most fishing vessels and leisure boats without AIS, as the AIS information was used to analyze the density of ships' traffic. In addition, the MTR policy is a new policy promoted by the Korean government, and a legal basis is required for the government of the ROK, which is a rule of law, to pursue a new policy. However, no legal or administrative definition for MTR has been established.

This study started by recognizing the two problems mentioned above. First, the MTR and traffic-dense area of fishing vessels and leisure boats were compared with each other to check whether the operation characteristics of fishing vessels and leisure boats were reflected in the water area identified by MTR. However, there were time and area limitations in the operation records of fishing vessels and leisure boats that could be used for this study. As a result, it was confirmed that only 8% of the fishing vessels' traffic-dense waters (36.25 km2 out of 452.91 km2) were included in the MTR, and only 2.7% (6,410 m out of 238 km) of the major routes of leisure boats were included in the MTR. There seems to be no clear standard for the percentage of the operating area of fishing vessels and leisure boats that should be included in the MTR. However, the figures of 8% and 2.7% are not considered sufficient. Since this study is the result of a survey in a limited time and place, it does not properly reflect the characteristics of the entire MTR.

In Korea, the operating records of ships such as fishing vessels are not disclosed. Therefore, in this study, the operational information of fishing vessels and leisure boats for 3 days that could be acquired was used. However, in order to analyze the suitability of the actual MTR, it is necessary to analyze the operating characteristics of fishing vessels and leisure boats in all of Korea's coastal waters. In addition, the operating records for a longer period of time should be checked so that the operating timing of the ship can reflect the operating characteristics of fishing vessels and leisure boats. Such research should be led by the Korean government, which has the authority to access the operating records of ships.

Next, the definition of MTR suitable for the three characteristics of MTR (a) Waters with high traffic density, (b) Waters that do not restrict existing activities, and (c) Waters divided into areas) that the Korean government thinks was reviewed in this study. If there are no regulations that restrict the behavior of people, the requirements of (b) will be satisfied. Therefore, only the characteristics of paragraphs (a) and (c) are considered when reviewing the definition of MTR. In addition, when discussing the definition of MTR with the Ministry of Legislation and the National Assembly in the process of enacting the law, the relationship with other laws will be considered as a top priority. The reason is that the definition of MTR reviewed in this study can be reflected in new laws related to MTR, so the legislative process must be considered. Therefore, the legal and administrative definitions of MTR were reviewed using the definition of traditional markets as stipulated in the existing law 'Special Act on the Development of Traditional Markets and Shopping Districts'. As a result, the definition of MTR was reviewed as "a range of bodies of water designated by the Minister of Oceans and Fisheries that is formed spontaneously or according to socioeconomic needs.” However, there are definitely limitations encountered in the process of conducting this study. Overcoming these limitations, it seems that more precise research is needed for the practical analysis of MTR. Fortunately, according to Article 58 (6) of the National Assembly Act of the ROK, the national assembly holds a public hearing or a hearing for the bills for enforcement of Acts (Korean Government, 2022). When a hearing is held, selected stakeholders from the National Assembly participate and express their opinions. This process allows a closer examination of the definition of MTR.

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# Appendices

*Appendix A: General Provisions on Ships’ Routeing*

|  |  |  |
| --- | --- | --- |
| No | Definitions of Ships’s Routeing | |
| 1 | Routeing system | Any system of one or more routes or routing measures aimed at reducing the risk of casualties; it includes traffic separation schemes, two-way routes, recommended tracks, areas to be avoided, inshore traffic zones, roundabouts, precautionary areas, and deep water routes. |
| 2 | Traffic separation scheme | A routing measure aimed at the separation of opposing streams of traffic by appropriate means and by the establishment of traffic lanes. |
| 3 | Separation zone or line | A zone or line separating the traffic lanes in which ships are proceeding in opposite or nearly opposite directions; or separating a traffic lane from the adjacent sea area, or separating traffic lanes designated for particular classes of a ship proceeding in the same direction |
| 4 | Traffic lane | An area within defined limits in which one-way traffic is established. Natural obstacles, including those forming separation zones, may constitute a boundary. |
| 5 | Roundabout | A routing measure comprising a separation point or circular separation zone and a circular traffic lane within defined limits. Traffic within the roundabout is separated by moving in a counterclockwise direction around the separation point or zone. |
| 6 | Inshore traffic zone | A routing measure comprising a designated area between the landward boundary of a traffic separation scheme and the adjacent coast, to be used in accordance with the provisions of rule 10(d), as amended, of the International Regulations for Preventing Collisions at Sea (Collision Regulations), 1972. |
| 7 | Two-way route | A route within defined limits inside which two-way traffic is established, aimed at providing safe passage of ships through waters where navigation is difficult or dangerous. |
| 8 | Recommended route | A route of undefined width, for the convenience of ships in transit, which is often marked by center line buoys. |
| 9 | Recommended track | A route has been specially examined to ensure so far as possible that it is free of dangers and that ships are advised to navigate along them. |
| 10 | Deep water route | A route within defined limits has been accurately surveyed for clearance of sea bottom and submerged obstacles as indicated on the chart. |
| 11 | Precautionary area | A routing measure comprising an area within defined limits where ships must navigate with particular caution and within which the direction of traffic flow may be recommended |
| 12 | Area to be avoided | A routing measure comprising an area within defined limits in which either navigation is particularly hazardous, or it is exceptionally important to avoid casualties and which should be avoided by all ships or certain classes of ship. |
| 13 | The established direction of traffic flow | A traffic flow pattern indicating the directional movement of traffic as established within a traffic separation scheme |
| 14 | Recommended direction of traffic flow | A traffic flow pattern indicates a recommended directional movement of traffic where it is impractical or unnecessary to adopt established directions of traffic flow. |

Source: IMO (1985)

Appendix B*: MTR designated case (space connecting each point according to latitude and longitude)*

|  |  |  |  |
| --- | --- | --- | --- |
| Zone | | Position | |
| Latitude (N) | Longitude (E) |
| 1 | 1 | 34.5725 | 125.5513 |
| 2 | 35.036 | 125.553 |
| 3 | 35.9175 | 125.646 |
| 4 | 36.6443 | 125.895 |
| 5 | 36.6363 | 125.9587 |
| 6 | 34.5711 | 125.638 |
| 2 | 1 | 36.5649 | 125.8678 |
| 2 | 35.9175 | 125.646 |
| 3 | 34.5955 | 125.0704 |
| 4 | 34.8473 | 124.8996 |
| 3 | 1 | 35.109 | 125.294 |
| 2 | 35.2783 | 125.3677 |
| 3 | 35.0794 | 125.5576 |
| 4 | 35.036 | 125.553 |
| 5 | 34.8117 | 125.5522 |
| 4 | 1 | 34.8056 | 125.1619 |
| 2 | 34.9009 | 125.2034 |
| 3 | 34.6674 | 125.3312 |
| 4 | 34.4866 | 125.5572 |
| 5 | 34.4644 | 125.5608 |
| 6 | 34.4059 | 125.5694 |
| 7 | 34.5056 | 125.4481 |
| 8 | 34.4966 | 125.4345 |
| 9 | 34.2175 | 125.5972 |
| 10 | 34.1564 | 125.6066 |
| 11 | 34.6495 | 125.2863 |
| 5 | 1 | 34.4644 | 125.5608 |
| 2 | 34.4672 | 125.5886 |
| 3 | 34.4725 | 125.6147 |
| 4 | 34.4725 | 125.6441 |
| 5 | 34.2197 | 125.6838 |
| 6 | 34.2175 | 125.5972 |
| 6 | 1 | 34.1233 | 125.7663 |
| 2 | 34.1147 | 126.4963 |
| 3 | 34.088 | 126.493 |
| 4 | 34.0663 | 126.4863 |
| 5 | 34.0347 | 125.4697 |
| 6 | 34.063 | 125.718 |
| 7 | 1 | 34.045 | 126.1946 |
| 2 | 34.044 | 126.2215 |
| 3 | 33.858 | 126.2306 |
| 4 | 33.867 | 126.1946 |
| 8 | 1 | 34.0383 | 126.3741 |
| 2 | 34.0367 | 126.4143 |
| 3 | 33.858 | 126.4824 |
| 4 | 33.858 | 126.4464 |
| 5 | 33.9614 | 126.4154 |
| 9 | 1 | 34.103 | 126.5563 |
| 2 | 34.1416 | 127.2333 |
| 3 | 34.0849 | 127.2416 |
| 4 | 34.0313 | 126.5513 |
| 5 | 34.0663 | 126.5447 |
| 6 | 34.078 | 126.548 |
| 10 | 1 | 33.9937 | 127.0016 |
| 2 | 34.0379 | 126.6352 |
| 3 | 34.0563 | 126.8732 |
| 4 | 34.0271 | 127.0619 |
| 11 | 1 | 34.0141 | 126.8329 |
| 2 | 34.0109 | 126.8601 |
| 3 | 33.9204 | 126.8691 |
| 4 | 33.9076 | 126.8461 |
| 12 | 1 | 34.0782 | 127.1542 |
| 2 | 34.0919 | 127.2918 |
| 3 | 33.8797 | 127.013 |
| 4 | 33.87 | 126.7782 |
| 13 | 1 | 34.1818 | 127.4177 |
| 2 | 34.2947 | 127.9284 |
| 3 | 34.4876 | 128.4968 |
| 4 | 34.5863 | 128.6311 |
| 5 | 34.5213 | 128.6844 |
| 6 | 34.4246 | 128.5238 |
| 7 | 34.2268 | 127.9483 |
| 8 | 34.115 | 127.4249 |
| 14 | 1 | 33.975 | 127.1389 |
| 2 | 34.0109 | 127.1838 |
| 3 | 33.9929 | 127.3547 |
| 4 | 34.002 | 127.6855 |
| 5 | 33.948 | 127.6425 |
| 6 | 33.939 | 127.3817 |
| 7 | 33.957 | 127.1298 |
| 15 | 1 | 33.9932 | 127.3641 |
| 2 | 34.1722 | 127.6925 |
| 3 | 34.1856 | 127.7555 |
| 4 | 33.9943 | 127.4062 |
| 16 | 1 | 33.885 | 127.1479 |
| 2 | 33.957 | 127.2828 |
| 3 | 33.948 | 127.3367 |
| 4 | 33.8872 | 127.2045 |
| 17 | 1 | 33.903 | 127.6065 |
| 2 | 34.2053 | 127.8478 |
| 3 | 34.2268 | 127.9483 |
| 4 | 33.9929 | 127.8403 |
| 18 | 1 | 34.2515 | 128.0203 |
| 2 | 34.2887 | 128.1285 |
| 3 | 34.1278 | 128.2091 |
| 4 | 34.0649 | 128.0382 |
| 19 | 1 | 34.4027 | 128.4601 |
| 2 | 34.3347 | 128.5778 |
| 3 | 34.284 | 128.5318 |
| 4 | 34.3667 | 128.3553 |
| 20 | 1 | 34.633 | 128.7144 |
| 2 | 35.1029 | 129.2444 |
| 3 | 35.0541 | 129.3062 |
| 4 | 34.5697 | 128.7677 |
| 21 | 1 | 37.4104 | 129.2613 |
| 2 | 37.4553 | 129.3152 |
| 3 | 37.2575 | 129.4501 |
| 4 | 37.0596 | 129.5311 |
| 5 | 36.2413 | 129.675 |
| 6 | 35.8995 | 129.6929 |
| 7 | 35.3599 | 129.558 |
| 8 | 35.0541 | 129.3062 |
| 9 | 35.1029 | 129.2444 |
| 10 | 35.395 | 129.4675 |
| 11 | 35.5046 | 129.5045 |
| 12 | 35.9535 | 129.603 |
| 13 | 36.1338 | 129.612 |
| 14 | 36.4751 | 129.558 |
| 15 | 37.0506 | 129.4723 |
| 16 | 37.2305 | 129.3962 |
| 22 | 1 | 36.7846 | 125.9475 |
| 2 | 36.8798 | 125.9967 |
| 3 | 36.9624 | 126.0219 |
| 4 | 37.0022 | 126.0219 |
| 5 | 36.9427 | 126.0329 |
| 6 | 36.7541 | 126 |
| 7 | 36.7624 | 126 |
| 23 | 1 | 37.2035 | 124.5039 |
| 2 | 37.3654 | 124.5039 |
| 3 | 37.0416 | 125.8438 |
| 4 | 37.0022 | 126.0329 |
| 5 | 36.9624 | 126.0219 |
| 24 | 1 | 36.9727 | 125.9575 |
| 2 | 36.9624 | 126.0219 |
| 3 | 36.8798 | 125.9967 |
| 4 | 36.7898 | 125.8079 |
| 5 | 36.6459 | 125.3222 |
| 6 | 36.7988 | 125.2773 |
| 7 | 36.9067 | 125.8169 |
| 25 | 1 | 35.297 | 125.1514 |
| 2 | 35.7556 | 124.7287 |
| 3 | 35.8815 | 124.8096 |
| 4 | 35.4498 | 125.2413 |
| 26 | 1 | 35.0492 | 125.0136 |
| 2 | 35.5847 | 124.6208 |
| 3 | 35.6387 | 124.6477 |
| 4 | 35.0888 | 125.0361 |
| 27 | 1 | 35.4678 | 124.5578 |
| 2 | 34.8473 | 124.8996 |
| 3 | 34.5955 | 125.0704 |
| 4 | 34.3167 | 125.1963 |
| 5 | 34.0649 | 125.655 |
| 6 | 34.0019 | 125.7719 |
| 7 | 33.8491 | 126.2575 |
| 8 | 33.903 | 127.5975 |
| 9 | 34.2268 | 128.4789 |
| 10 | 34.5865 | 128.8116 |
| 11 | 35.0452 | 129.3152 |
| 12 | 35.3659 | 129.5727 |
| 13 | 35.8815 | 129.7739 |
| 14 | 35.8366 | 129.8818 |
| 15 | 35.3149 | 129.6839 |
| 16 | 34.9642 | 129.3782 |
| 17 | 34.7933 | 129.1623 |
| 18 | 34.6405 | 129.0364 |
| 19 | 34.1728 | 128.6857 |
| 20 | 33.7591 | 127.6065 |
| 21 | 33.7411 | 126.2485 |
| 22 | 33.894 | 125.7269 |
| 23 | 34.2088 | 125.0974 |
| 24 | 35.3869 | 124.5039 |
| 28 | 1 | 34.7484 | 124.8276 |
| 2 | 34.6045 | 124.8996 |
| 3 | 34.4786 | 124.7826 |
| 4 | 34.6225 | 124.7107 |
| 29 | 1 | 34.5415 | 124.9355 |
| 2 | 34.3437 | 125.0255 |
| 3 | 34.1458 | 124.9625 |
| 4 | 34.3347 | 124.8546 |
| 30 | 1 | 33.7411 | 126.2485 |
| 2 | 33.7861 | 125.4122 |
| 3 | 33.975 | 124.7377 |
| 4 | 34.5505 | 124.5128 |
| 5 | 34.7484 | 124.6477 |
| 6 | 34.0829 | 124.9895 |
| 7 | 33.975 | 125.1244 |
| 8 | 33.894 | 125.7359 |
| 31 | 1 | 33.7431 | 126.2123 |
| 2 | 33.7422 | 126.2395 |
| 3 | 33.7052 | 126.2395 |
| 4 | 33.5932 | 126.2507 |
| 5 | 33.5793 | 126.2267 |
| 6 | 33.6962 | 126.2126 |
| 32 | 1 | 33.7411 | 126.2485 |
| 2 | 33.7411 | 126.2665 |
| 3 | 33.7321 | 126.2665 |
| 4 | 33.6962 | 126.2755 |
| 5 | 33.6602 | 126.2845 |
| 6 | 33.6198 | 126.3004 |
| 7 | 33.6118 | 126.2858 |
| 8 | 33.6916 | 126.2575 |
| 9 | 33.7231 | 126.2485 |
| 33 | 1 | 33.2606 | 125.7507 |
| 2 | 33.5534 | 126.1766 |
| 3 | 33.7449 | 126.5338 |
| 4 | 33.7476 | 126.7387 |
| 5 | 33.4803 | 126.2575 |
| 6 | 33.2105 | 125.8348 |
| 7 | 33.148 | 125.7878 |
| 34 | 1 | 33.1656 | 126.7791 |
| 2 | 33.4803 | 127.1389 |
| 3 | 33.7591 | 127.4536 |
| 4 | 33.7591 | 127.6245 |
| 5 | 33.3814 | 127.2648 |
| 6 | 33.0846 | 126.8781 |
| 35 | 1 | 33.9718 | 128.1613 |
| 2 | 34.0289 | 128.308 |
| 3 | 34.0289 | 128.6048 |
| 4 | 33.966 | 128.5508 |
| 36 | 1 | 34.1728 | 128.6857 |
| 2 | 34.27 | 128.7586 |
| 3 | 34.2178 | 128.8116 |
| 4 | 34.1548 | 128.7127 |
| 37 | 1 | 37.0022 | 126.0329 |
| 2 | 37.0506 | 126.0819 |
| 3 | 37.1622 | 126.1547 |
| 4 | 37.1496 | 126.1766 |
| 5 | 37.0956 | 126.1444 |
| 6 | 37.0776 | 126.1586 |
| 7 | 37.0686 | 126.1766 |
| 8 | 37.0866 | 126.2665 |
| 9 | 37.092 | 126.2786 |
| 10 | 37.103 | 126.2891 |
| 11 | 37.1244 | 126.3036 |
| 12 | 37.1166 | 126.3313 |
| 13 | 37.0902 | 126.3002 |
| 14 | 37.0733 | 126.2769 |
| 15 | 37.0644 | 126.2847 |
| 16 | 37.0716 | 126.298 |
| 17 | 37.0827 | 126.3088 |
| 18 | 37.1468 | 126.3704 |
| 19 | 37.1496 | 126.4518 |
| 20 | 37.1425 | 126.5286 |
| 21 | 37.1277 | 126.5202 |
| 22 | 37.1311 | 126.4535 |
| 23 | 37.1275 | 126.4446 |
| 24 | 37.1226 | 126.3744 |
| 25 | 37.0756 | 126.3295 |
| 26 | 37.0722 | 126.3216 |
| 27 | 37.0613 | 126.3115 |
| 28 | 37.0522 | 126.2955 |
| 29 | 36.9427 | 126.1406 |
| 38 | 1 | 37.0361 | 126.3251 |
| 2 | 37.0522 | 126.2955 |
| 3 | 37.0613 | 126.3115 |
| 4 | 37.0722 | 126.3216 |
| 5 | 37.0416 | 126.3425 |
| 39 | 1 | 36.8905 | 126.1572 |
| 2 | 36.8738 | 126.1583 |
| 3 | 36.8258 | 126.0957 |
| 4 | 36.7898 | 126.0237 |
| 5 | 36.8394 | 126.0636 |
| 40 | 1 | 36.1957 | 126.349 |
| 2 | 36.1894 | 126.3501 |
| 3 | 36.1783 | 126.3205 |
| 4 | 36.1513 | 126.2755 |
| 5 | 36.0101 | 126.0457 |
| 6 | 36.0254 | 125.9967 |
| 7 | 36.1423 | 126.2036 |
| 8 | 36.1693 | 126.2485 |
| 9 | 36.1783 | 126.2755 |
| 10 | 36.1963 | 126.2935 |
| 41 | 1 | 35.9715 | 126.3586 |
| 2 | 35.9274 | 126.3584 |
| 3 | 35.9175 | 126.0867 |
| 4 | 35.8905 | 126.0327 |
| 5 | 35.7167 | 125.8159 |
| 6 | 36.1963 | 125.8888 |
| 7 | 36.1064 | 125.9248 |
| 8 | 36.0254 | 125.9967 |
| 9 | 35.9804 | 126.1406 |
| 10 | 35.9715 | 126.2216 |
| 42 | 1 | 35.4858 | 125.7809 |
| 2 | 35.5266 | 125.7864 |
| 3 | 35.3509 | 125.9697 |
| 4 | 35.27 | 125.9877 |
| 5 | 35.1351 | 126.0057 |
| 6 | 35.0362 | 126.0147 |
| 7 | 34.9822 | 126.0687 |
| 8 | 34.9552 | 126.1136 |
| 9 | 34.8653 | 126.1766 |
| 10 | 34.7755 | 126.2883 |
| 11 | 34.7755 | 126.2397 |
| 12 | 34.8787 | 126.1496 |
| 13 | 35.0362 | 125.9877 |
| 14 | 35.1081 | 125.9877 |
| 15 | 35.1531 | 125.9877 |
| 16 | 35.27 | 125.9697 |
| 17 | 35.3599 | 125.9338 |
| 43 | 1 | 34.8758 | 125.6853 |
| 2 | 34.9786 | 125.7 |
| 3 | 34.8293 | 125.8169 |
| 4 | 34.6944 | 125.8978 |
| 5 | 34.6135 | 125.9428 |
| 6 | 34.4696 | 126.0237 |
| 7 | 34.4516 | 126.0237 |
| 8 | 34.4516 | 126.0057 |
| 9 | 34.5685 | 125.9338 |
| 10 | 34.6584 | 125.8978 |
| 11 | 34.8023 | 125.7899 |
| 44 | 1 | 34.462 | 126.0623 |
| 2 | 34.4731 | 126.0852 |
| 3 | 34.4672 | 126.0911 |
| 4 | 34.4521 | 126.0786 |
| 5 | 34.4519 | 126.0694 |
| 45 | 1 | 34.4516 | 126.0237 |
| 2 | 34.4516 | 126.0408 |
| 3 | 34.4425 | 126.0505 |
| 4 | 34.4156 | 126.0237 |
| 5 | 34.4066 | 126.0147 |
| 6 | 34.3976 | 125.9697 |
| 7 | 34.3935 | 125.8583 |
| 8 | 34.3386 | 125.804 |
| 9 | 34.4422 | 125.7037 |
| 10 | 34.4426 | 125.9877 |
| 11 | 34.4516 | 126.0057 |
| 46 | 1 | 34.4066 | 126.0507 |
| 2 | 34.4194 | 126.0275 |
| 3 | 34.4425 | 126.0505 |
| 4 | 34.4252 | 126.0694 |
| 5 | 34.4166 | 126.0786 |
| 6 | 34.4066 | 126.0867 |
| 7 | 34.3617 | 126.1136 |
| 8 | 34.3487 | 126.1496 |
| 9 | 34.3257 | 126.2036 |
| 10 | 34.2897 | 126.2036 |
| 11 | 34.1536 | 126.3433 |
| 12 | 34.1151 | 126.4586 |
| 13 | 34.1168 | 126.3182 |
| 14 | 34.2537 | 126.2036 |
| 15 | 34.1652 | 126.2069 |
| 16 | 34.1669 | 126.1946 |
| 17 | 34.2537 | 126.1946 |
| 18 | 34.2717 | 126.1766 |
| 19 | 34.3257 | 126.0687 |
| 47 | 1 | 34.5225 | 125.638 |
| 2 | 34.446 | 125.7 |
| 3 | 34.3347 | 125.8079 |
| 4 | 34.2448 | 125.8888 |
| 5 | 34.1998 | 125.9697 |
| 6 | 34.1534 | 126.2876 |
| 7 | 34.1168 | 126.3182 |
| 8 | 34.1189 | 126.1136 |
| 9 | 34.1458 | 126.0777 |
| 10 | 34.1728 | 125.9428 |
| 11 | 34.2268 | 125.8618 |
| 12 | 34.3737 | 125.6596 |
| 13 | 34.4725 | 125.6441 |
| 48 | 1 | 34.3167 | 126.2036 |
| 2 | 34.3077 | 126.2216 |
| 3 | 34.3077 | 126.4824 |
| 4 | 34.2717 | 126.5363 |
| 5 | 34.2717 | 126.6532 |
| 6 | 34.2627 | 126.6622 |
| 7 | 34.2616 | 126.7555 |
| 8 | 34.2463 | 126.755 |
| 9 | 34.2448 | 126.6532 |
| 10 | 34.2537 | 126.6442 |
| 11 | 34.2537 | 126.5183 |
| 12 | 34.2897 | 126.4824 |
| 13 | 34.2897 | 126.2845 |
| 14 | 34.2987 | 126.2845 |
| 15 | 34.2987 | 126.2036 |
| 49 | 1 | 34.2836 | 126.7991 |
| 2 | 34.3145 | 126.772 |
| 3 | 34.3236 | 126.7811 |
| 4 | 34.2836 | 126.8133 |
| 50 | 1 | 34.2266 | 126.8177 |
| 2 | 34.1189 | 126.8151 |
| 3 | 34.1189 | 126.8061 |
| 4 | 34.2266 | 126.7991 |
| 51 | 1 | 33.463 | 126.2304 |
| 2 | 33.4745 | 126.2484 |
| 3 | 33.4236 | 126.2481 |
| 4 | 33.4179 | 126.2412 |
| 52 | 1 | 33.5154 | 126.3207 |
| 2 | 33.5253 | 126.3385 |
| 3 | 33.4752 | 126.3439 |
| 4 | 33.4745 | 126.3205 |
| 53 | 1 | 33.625 | 126.5179 |
| 2 | 33.644 | 126.5521 |
| 3 | 33.5613 | 126.5633 |
| 4 | 33.5433 | 126.5453 |
| 54 | 1 | 33.7482 | 126.7858 |
| 2 | 33.7487 | 126.8196 |
| 3 | 33.5523 | 126.5723 |
| 4 | 33.5613 | 126.5633 |
| 55 | 1 | 33.7496 | 126.8862 |
| 2 | 33.7507 | 126.969 |
| 3 | 33.5433 | 126.5903 |
| 4 | 33.5523 | 126.5723 |
| 56 | 1 | 34.2783 | 126.8994 |
| 2 | 34.2987 | 126.968 |
| 3 | 34.2987 | 127.1479 |
| 4 | 34.3257 | 127.2288 |
| 5 | 34.3437 | 127.3187 |
| 6 | 34.3527 | 127.3637 |
| 7 | 33.3347 | 127.3637 |
| 8 | 34.3257 | 127.3097 |
| 9 | 34.2824 | 127.1556 |
| 10 | 34.2807 | 126.977 |
| 11 | 34.2636 | 126.9033 |
| 57 | 1 | 34.4653 | 127.443 |
| 2 | 34.3976 | 127.3997 |
| 3 | 34.3617 | 127.3997 |
| 4 | 34.3527 | 127.3637 |
| 5 | 34.4246 | 127.3637 |
| 6 | 34.466 | 127.384 |
| 58 | 1 | 34.3617 | 127.3997 |
| 2 | 34.4696 | 127.793 |
| 3 | 34.4606 | 127.7954 |
| 4 | 34.3527 | 127.4087 |
| 5 | 34.3347 | 127.3637 |
| 6 | 34.3527 | 127.3637 |
| 59 | 1 | 34.7184 | 127.8243 |
| 2 | 34.7124 | 127.8313 |
| 3 | 34.6225 | 127.8313 |
| 4 | 34.6135 | 127.8403 |
| 5 | 34.5685 | 127.8403 |
| 6 | 34.5595 | 127.8493 |
| 7 | 34.491 | 127.856 |
| 8 | 34.4835 | 127.8347 |
| 9 | 34.5146 | 127.8313 |
| 10 | 34.5775 | 127.8313 |
| 11 | 34.5865 | 127.8224 |
| 12 | 34.7034 | 127.8224 |
| 60 | 1 | 34.4696 | 127.793 |
| 2 | 34.4696 | 127.8134 |
| 3 | 34.4835 | 127.8347 |
| 4 | 34.4985 | 127.8775 |
| 5 | 34.4722 | 127.8617 |
| 6 | 34.4606 | 127.8134 |
| 7 | 34.4606 | 127.7954 |
| 61 | 1 | 34.3527 | 127.4087 |
| 2 | 34.3976 | 127.7864 |
| 3 | 34.3437 | 127.7324 |
| 4 | 34.3347 | 127.3637 |
| 62 | 1 | 34.1908 | 127.4536 |
| 2 | 34.2537 | 127.5975 |
| 3 | 34.3437 | 127.7324 |
| 4 | 34.3976 | 127.7864 |
| 5 | 34.4516 | 127.8493 |
| 6 | 34.5415 | 127.9033 |
| 7 | 34.5415 | 127.9303 |
| 8 | 34.4516 | 127.9213 |
| 9 | 34.1066 | 127.8763 |
| 10 | 34.2807 | 127.7864 |
| 11 | 34.2448 | 127.7144 |
| 63 | 1 | 34.3979 | 127.8701 |
| 2 | 34.4112 | 127.919 |
| 3 | 34.3175 | 127.9138 |
| 4 | 34.2807 | 127.7864 |
| 64 | 1 | 34.5415 | 127.9303 |
| 2 | 34.5415 | 128.0202 |
| 3 | 34.5056 | 128.0382 |
| 4 | 34.3617 | 128.1371 |
| 5 | 34.2897 | 127.9123 |
| 6 | 34.4516 | 127.9213 |
| 65 | 1 | 34.4575 | 128.0713 |
| 2 | 34.4817 | 128.1484 |
| 3 | 34.4312 | 128.2565 |
| 4 | 34.3791 | 128.1251 |
| 66 | 1 | 34.4156 | 128.29 |
| 2 | 34.5415 | 128.0202 |
| 3 | 34.5685 | 128.0652 |
| 4 | 34.5325 | 128.317 |
| 5 | 34.4876 | 128.4968 |
| 67 | 1 | 34.5947 | 127.9227 |
| 2 | 34.5947 | 127.9977 |
| 3 | 34.5685 | 128.0652 |
| 4 | 34.5415 | 128.0202 |
| 5 | 34.5415 | 127.9303 |
| 6 | 34.5415 | 127.9033 |
| 68 | 1 | 34.6764 | 127.9752 |
| 2 | 34.6764 | 128.0742 |
| 3 | 34.7304 | 128.1371 |
| 4 | 34.7436 | 128.1911 |
| 5 | 34.7484 | 128.263 |
| 6 | 34.694 | 128.396 |
| 7 | 34.6854 | 128.4159 |
| 8 | 34.6854 | 128.5328 |
| 9 | 34.6764 | 128.5778 |
| 10 | 34.6764 | 128.6138 |
| 11 | 34.6584 | 128.6138 |
| 12 | 34.6674 | 128.4249 |
| 13 | 34.7034 | 128.308 |
| 14 | 34.7214 | 128.2091 |
| 15 | 34.7214 | 128.1731 |
| 16 | 34.6584 | 128.0921 |
| 17 | 34.6584 | 127.9932 |
| 69 | 1 | 34.5707 | 128.0595 |
| 2 | 34.6225 | 128.1336 |
| 3 | 34.6854 | 128.2055 |
| 4 | 34.7124 | 128.254 |
| 5 | 34.7091 | 128.2766 |
| 6 | 34.68 | 128.2188 |
| 7 | 34.6045 | 128.1371 |
| 8 | 34.5664 | 128.0802 |
| 70 | 1 | 34.5312 | 128.3224 |
| 2 | 34.6135 | 128.5508 |
| 3 | 34.6495 | 128.6138 |
| 4 | 34.6405 | 128.6227 |
| 5 | 34.5775 | 128.4968 |
| 6 | 34.5221 | 128.3588 |
| 71 | 1 | 34.5103 | 128.406 |
| 2 | 34.5638 | 128.5598 |
| 3 | 34.6405 | 128.6497 |
| 4 | 34.6315 | 128.6677 |
| 5 | 34.57 | 128.6019 |
| 6 | 34.5 | 128.447 |
| 72 | 1 | 34.6764 | 128.6138 |
| 2 | 34.8293 | 128.8026 |
| 3 | 34.7394 | 128.8206 |
| 4 | 34.6315 | 128.6677 |
| 5 | 34.6405 | 128.6497 |
| 6 | 34.6405 | 128.6227 |
| 7 | 34.6495 | 128.6138 |
| 8 | 34.6584 | 128.6138 |
| 73 | 1 | 34.9726 | 128.7961 |
| 2 | 34.9781 | 128.822 |
| 3 | 34.8563 | 128.9645 |
| 4 | 34.7346 | 128.8289 |
| 5 | 34.7394 | 128.8296 |
| 6 | 34.7394 | 128.8206 |
| 7 | 34.8293 | 128.8026 |
| 74 | 1 | 34.9731 | 128.8273 |
| 2 | 34.9732 | 128.9735 |
| 3 | 34.9749 | 129.0814 |
| 4 | 34.9706 | 129.0951 |
| 5 | 34.9552 | 129.0814 |
| 6 | 34.9462 | 128.9915 |
| 7 | 34.9463 | 128.8593 |
| 75 | 1 | 35.0212 | 129.0157 |
| 2 | 35.0226 | 129.0228 |
| 3 | 35.0377 | 129.0281 |
| 4 | 35.045 | 129.0311 |
| 5 | 35.0443 | 129.037 |
| 6 | 34.9822 | 129.1084 |
| 7 | 34.9706 | 129.0951 |
| 8 | 34.9749 | 129.0814 |
| 9 | 34.974 | 129.0184 |
| 76 | 1 | 35.048 | 129.1269 |
| 2 | 35.0736 | 129.1508 |
| 3 | 35.0721 | 129.2073 |
| 4 | 35.003 | 129.1311 |
| 77 | 1 | 35.3793 | 129.3793 |
| 2 | 35.3793 | 129.3859 |
| 3 | 35.3044 | 129.3983 |
| 4 | 35.2932 | 129.3897 |
| 78 | 1 | 35.403 | 129.418 |
| 2 | 35.403 | 129.4241 |
| 3 | 35.3563 | 129.4379 |
| 4 | 35.3343 | 129.4211 |
| 79 | 1 | 36.1308 | 129.612 |
| 2 | 36.0574 | 129.6044 |
| 3 | 36.0766 | 129.6013 |
| 4 | 36.1091 | 129.5588 |
| 5 | 36.0596 | 129.4958 |
| 6 | 36.1211 | 129.4958 |
| 7 | 36.1313 | 129.4951 |
| 80 | 1 | 36.1311 | 129.5379 |
| 2 | 36.1963 | 129.603 |
| 3 | 36.1763 | 129.6052 |
| 4 | 36.131 | 129.5675 |
| 81 | 1 | 36.7179 | 129.5221 |
| 2 | 36.619 | 129.5401 |
| 3 | 36.1312 | 129.5048 |
| 4 | 36.1313 | 129.4951 |
| 5 | 36.1333 | 129.4861 |
| 6 | 36.3492 | 129.4951 |
| 82 | 1 | 36.2761 | 129.6688 |
| 2 | 37.4463 | 130.88 |
| 3 | 37.4553 | 130.88 |
| 4 | 37.4643 | 130.898 |
| 5 | 37.4373 | 130.898 |
| 6 | 36.2502 | 129.675 |
| 83 | 1 | 37.145 | 129.3863 |
| 2 | 37.145 | 129.3933 |
| 3 | 37.1169 | 129.4443 |
| 4 | 37.1048 | 129.4494 |
| 84 | 1 | 37.2116 | 129.3766 |
| 2 | 37.2121 | 129.404 |
| 3 | 37.1499 | 129.4303 |
| 4 | 37.145 | 129.3986 |
| 85 | 1 | 37.2116 | 129.353 |
| 2 | 37.2701 | 129.3665 |
| 3 | 37.2629 | 129.3719 |
| 4 | 37.2116 | 129.357 |
| 86 | 1 | 37.4302 | 129.1988 |
| 2 | 34.4284 | 129.2073 |
| 3 | 37.424 | 129.2116 |
| 4 | 37.43 | 129.1961 |
| 87 | 1 | 37.4373 | 129.2073 |
| 2 | 37.4373 | 129.2433 |
| 3 | 37.4104 | 129.2613 |
| 4 | 37.4194 | 129.2163 |
| 5 | 37.4284 | 129.2073 |
| 88 | 1 | 37.5221 | 129.201 |
| 2 | 37.5273 | 129.2253 |
| 3 | 37.4463 | 129.3062 |
| 4 | 37.4104 | 129.2613 |
| 5 | 37.4373 | 129.2433 |
| 6 | 37.4816 | 129.2009 |
| 89 | 1 | 37.4994 | 129.1919 |
| 2 | 37.4994 | 129.2011 |
| 3 | 37.4963 | 129.2008 |
| 4 | 37.4963 | 127.1938 |
| 90 | 1 | 37.5361 | 129.1252 |
| 2 | 37.5362 | 129.1875 |
| 3 | 37.5221 | 129.201 |
| 4 | 37.5273 | 129.1444 |
| 5 | 37.5361 | 129.1222 |
| 91 | 1 | 37.6262 | 129.0904 |
| 2 | 37.6262 | 129.1264 |
| 3 | 37.5273 | 129.2253 |
| 4 | 37.5221 | 129.201 |
| 5 | 37.5812 | 129.1444 |
| 6 | 37.6082 | 129.1174 |
| 7 | 37.6082 | 129.0904 |
| 92 | 1 | 37.6186 | 129.0893 |
| 2 | 37.6186 | 129.0904 |
| 3 | 37.6082 | 129.0904 |
| 4 | 37.6161 | 129.0776 |
| 5 | 37.6161 | 129.0893 |
| 93 | 1 | 38.1965 | 128.8118 |
| 2 | 38.1658 | 128.7113 |
| 3 | 38.0039 | 128.8656 |
| 4 | 37.869 | 128.9915 |
| 5 | 37.7701 | 129.0814 |
| 6 | 37.7071 | 129.1174 |
| 7 | 37.6262 | 129.1623 |
| 8 | 37.5722 | 129.1803 |
| 9 | 37.5902 | 129.1623 |
| 10 | 37.6892 | 129.1084 |
| 11 | 37.7611 | 129.0724 |
| 12 | 37.86 | 128.9825 |
| 13 | 37.9949 | 128.8566 |
| 14 | 38.1568 | 128.7037 |
| 15 | 38.1954 | 128.6087 |

Source: MOF (2023)