

# Collision Analyze and Map Plotting of Korea – Japan navigating vessels

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## ABSTRACT

Korea-Japan route is important for both Korean and Japanese economy and shipping industry. However, presences of many vessels in this sea area, geographical characteristics, and a short voyage make this route dangerous. In this paper, written verdicts of Korea Central Maritime Safety Tribunal and accident survey reports of Japan Transportation Safety Board were analyzed. Also, Ship collisions occurred in this route are classified by vessel types, encounter situation and main causes, or other factors. Then, their positions and traits are plotted on map by Geographic Information System (GIS) software. From analyzing data, results were found as follows. First, collision occurs throughout the entire shipping route. Second, accidents between fishing boat and cargo ship usually occur in Korea Strait and South Sea of Korea. Also, fishing boats on this route may operate in drowsy condition due to fatigue. In contrast, there is a high risk of collision with cargo ships on Kanmon Straits. In addition, accidents related with cargo ships are mainly caused by the improper lookout and the misuse of VHF.

## 1. Introduction

Many of Japanese cargoes make a transshipment through Busan port of South Korea. In addition, Korean shipping companies occupy about 70% of bottoms in Korea - Japan route. Therefore, it can be said that this shipping route is very important for the economy and shipping industry of two countries. Despite this importance, there are numerous risks in this shipping route. For examples, merchant ships and passenger ships navigating between the two countries, ships having same routes from other countries, ships crossing Korea Strait (Tsushima Strait), the presence of domestic ships and fishing boats near the coast exists. Moreover, geographical characteristics of South Sea of Korea, Kanmon Strait and Seto Inland Sea make safe navigation more difficult. What was worse, voyage takes only 1 or 2 days in this route, and it causes fatigue to navigators. Recently, in May 2021, chemical tanker ULSAN PIONEER belong to Korean Company and Japanese Car carrier BYAKKO collided in Seto Inland Sea and 3 crews were missing.

Hence, it is necessary to clarify the situation and cause of the collision on this passage to prevent economic loss and to save human lives. There is research on collisions which occurred in both territorial waters. Kim (2006) and Kim (2011) focus on human factors in ship accidents in Korean waters and Lee (2013) described collisions between fishing vessel and non-fishing vessel using written verdicts. In Japan, Yamashita (2013) pointed out characteristics of ship's collision in Seto Inland Sea using GIS. However, no studies focus on accidents such as collision of Korea – Japan navigating vessels. With these backgrounds, this study aims to make clear characteristic of the actual situation of collision accidents which Korea – Japan navigating vessels involved. For this purpose, we collected information related accidents from Korean and Japanese judgments, such as types of ships, encounter situations, and causes of accidents, and plotted the accidents on a GIS map.

## 2. Methodology

### 2.1 Data Source of Study

In this study, Korea Central Marine Safety Tribunal's written verdict, special survey report, and ship accident investigation report of Japan Transport Safety Board (JTSB) from 2010 to 2020 were analyzed. And all accidents picked up were that their arrival or departure ports are clearly stated as Korea and Japan. Even if the pilot boarded on Korea – Japan navigating vessels, captains always have responsibility for the ship accident. For this reason, accidents in pilot on board situation also included. Furthermore, if Korea-Japan navigating vessels were not underway using engine, it was not included in database. On the other hand, status of opponent vessels was not considered on investigating database.

When accidents reports were found in both organizations, this study preferred Korean written verdicts because the accident of Korean flag vessels was the most common case. However, there were no reports of all collisions that occurred, and the criteria for reporting or not by each organization are as follows.

In Korea Central Maritime Safety Tribunal, no decision is made on marine accidents under the following matters. Article 22(1). Marine accidents of foreign vessels not related to Korean vessels outside Korean territorial waters. However, marine accidents of ships on Bare Boat Charter with Hire Purchase and marine accidents that may affect the protection and preservation of the marine environment in exclusive economic zones are excluded. <Revised March 9, 2020> Article 46 (1) (a). Among the collision cases, only equipment was damaged, or the outer plate was

lightly damaged, but it did not interfere with the ship's navigation. Article 46(8): A case of a foreign ship in the territorial waters of Korea or between foreign ships and is recognized as having no real benefit from the judgment. <Revised January 31, 2017>

The Japan Transportation Safety Board investigates the following accidents. (i) damage to the ship or facilities other than the ship in relation to the operation (ii) injury of the ship's structure, cost, or operation; (iii) a serious incident (which is deemed to be at risk of an accident)

## 2.2 Research Method

Vessel types, main causes, when the collision occurred, occurred under what circumstances (applied navigational rule), what was the main cause of the accident, the size of the ship, and the size of the collided opponent ship were investigated. Also, positions of collisions accidents were marked on map with each characteristic that analyzed at above phase on map with a freeware GIS (Geographic Information System) software, QGIS. For the GIS, open street map was used in this study.

In this study, some words were defined as follows according to Korea Maritime Safety Tribunal, because Korea Maritime Safety Tribunal and JTSTB used different terms to describe. For this reason, this research divided causes of accidents as per following words.

- (1) Improper lookout: Status that do not keep a proper lookout – by sight, hearing, or all available means at all times.
- (2) Inappropriate Navigation: Violation of COLREG and navigational rule such as local rule in port limit or special sea area.
- (3) Inappropriate Maneuvering: Improper steering, unreasonable operation, failure to secure a safe distance, non-compliance with agreement.
- (4) Restricted ability in maneuvering: a vessel which from the nature of her work is restricted in her ability to maneuver therefore unable to keep out of the way of another vessel such as vessel engaged in a towing operation. In this paper, vessels engaged in fishing were also included in this status.

## 3. Result

### 3.1 Overview

An accident analysis was conducted on a total of 49 reports, including 27 decisions by Korea Central Maritime Safety Tribunal and 22 reports of JTSTB's ship accident investigation report. The outline of the accident is summarized in Tables 1 to 5, and Figure 1 is a GIS map indicating the entire accident targeted by this study. Also, in figure 1, the mark of each shape represents navigation rules applied to each case, and their color means type of accident.

Table 1. Main cause of ship collision

Main Cause of Collision	Number
Improper Lookout	30 (61%)
Inappropriate Maneuvering	11 (23%)
Inappropriate Navigation	8 (16%)
Total	49

Table 2. Vessel type of ship collision

Vessel Type	Number
Cargo Ship - Fishing Boat	27 (55%)
Cargo Ship - Cargo Ship	16 (33%)
Cargo Ship - Tugboat	4 (8%)
Cargo Ship - Passenger Ship	1 (2%)
Passenger Ship - Fishing Boat	1 (2%)
Total	49

Table 3. Encounter situation during ship collision

Encounter Situation or Applied Rules	Number
Crossing	17 (35%)
Restricted Ability in Maneuvering	11(23%)
Anchoring	6 (12%)
Local Rule	6 (12%)
Overtaking	4 (8%)
Head-On	2 (4%)
Drifting	1 (2%)
Restricted Visibility	1 (2%)
Unknown	1 (2%)
Total	49

Table 4. Weather condition during ship collision

Weather Condition	Number
Daytime (Clear Visibility)	28 (57%)
Nighttime (Clear Visibility)	18 (37%)
Daytime (Restricted Visibility)	1 (2%)
Nighttime (Restricted Visibility)	1 (2%)
Nighttime (Heavy Weather)	1 (2%)
Total	49

Table 5. Attributable reasons to which vessel

Vessel	Number
Korea - Japan navigating vessel	36 (74%)
Opponent vessel	10 (20%)
Accidents between Korea - Japan navigating vessel	3 (6%)
Total	49

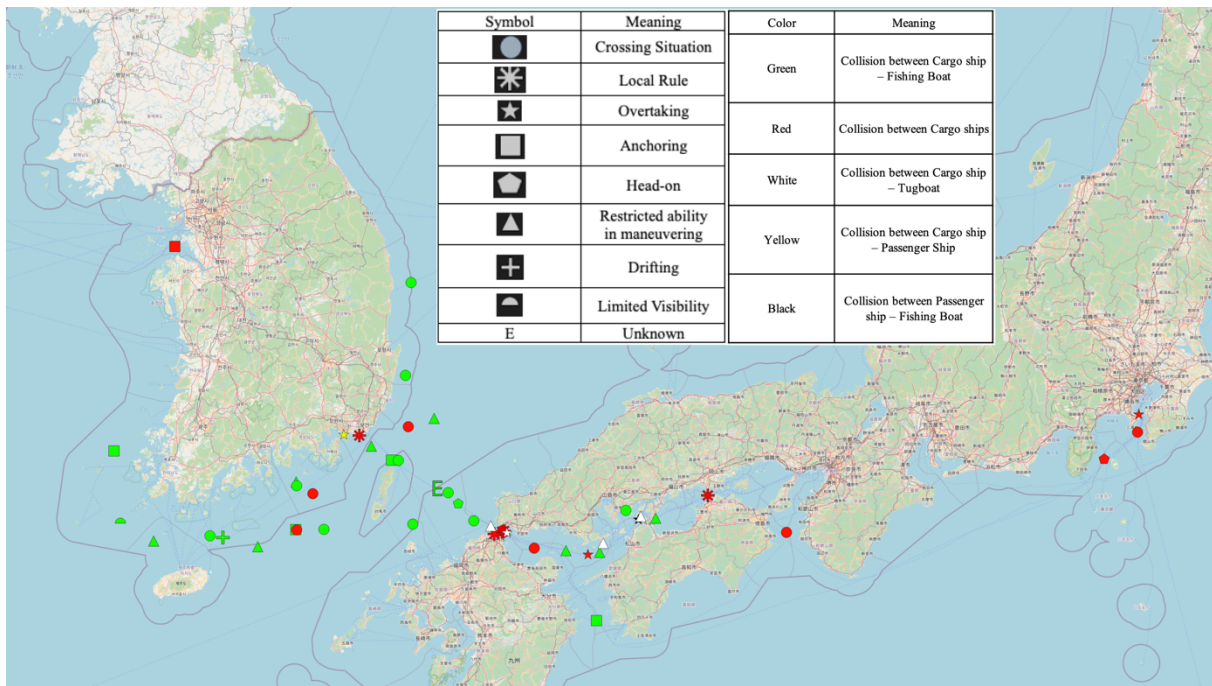


Figure 1. All accidents plotted on map.

First of all, entire 49 collisions were occurred due to human factors; 30 case of improper lookout (61%), 11 cases of inappropriate navigation (23%), and 8 cases of inappropriate maneuvering (16%). Secondly, it was found that collisions between cargo ship and fishing boat recorded 27 cases (55%). Collisions of cargo ship – cargo ship follow (16 cases, 33%). Cargo ship – Tugboat accidents were 4 cases (8%), but cargo ship – passenger ship and passenger ship – fishing boat were occurred each 1 case (2%). Thirdly, when focusing on the encounter situation and applied navigational rule, crossing situation and restricted ability in maneuvering, anchoring and local rule was the largest with 17 cases, 11 cases, 6 cases, 6 cases, respectively.

Regarding checking the time and weather collisions occurred, there were 28 cases after sunset on a clear day and 18 cases after sunrise on a clear day, 1 case at night during the heavy weather, and each 1 case at day and night under the limited visibility.

Subsequently, there were 52 Korea – Japan navigating ships in 49 cases because of 3 accidents between them. Regarding their flags, there were 34 Korean ships. Also, 5 were Cambodian and 4 were Panamanian. Their average gross ton was 4611 ton(M/T). Indeed, there were 51 cargo ships and 1 passenger ship.

Additionally, attributable reasons of accidents were usually on Korea – Japan navigating vessels. Among 46 collisions except 3 that happened between Korea – Japan vessel, 36 accidents (76%) were caused because of the fault of them. However, opponent vessels who were not navigating between Korea and Japan were only 10 cases (20%).

Lastly, it was found that there were each 10 accidents in the Korean Strait, the Seto Inland Sea, and the southern coast of Korea respectively, and 6 cases were occurred in the Kanmon Strait as shown on the figure 1. Also, it can be found that there were no accidents from south of Shikoku Island to Izu Peninsula.

As written in above paragraph, for the next, accidents between cargo ship – fishing boat, cargo ship – cargo ship, and cargo ship – tugboat with high frequency will be described in order.

### 3.2 Cargo Ship – Fishing Boat

Accidents between cargo ships and fishing boats are plotted on map with their encounter situation as shown on Figure 2.

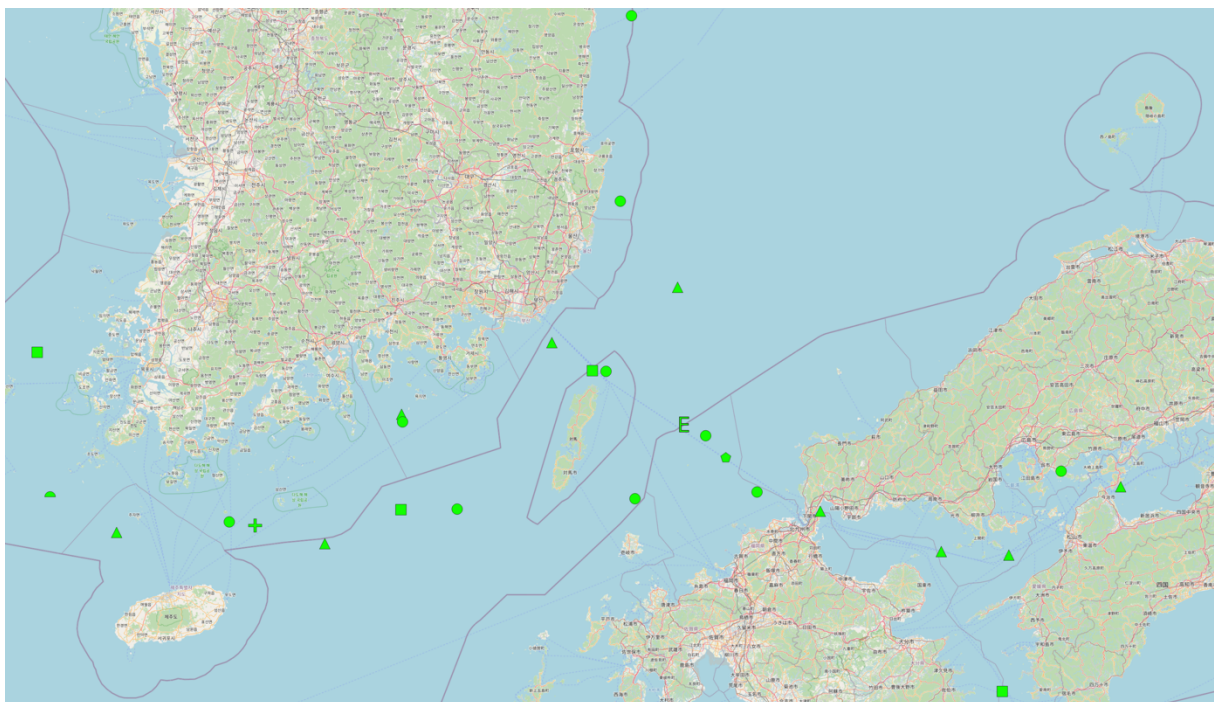


Figure 2. Hazard map of accidents between cargo ship and fishing boat

Collisions between cargo ship and fishing boat were the largest number with 27 cases (55%) as described on 3. In details, crossing situation was 10 cases, restricted ability in maneuvering (vessel engaged in fishing) was 8 cases, anchoring 5 cases, head-on, restricted visibility, drifting, and other cases were each 1 case. Main factors in this type of accident were 23 cases of improper lookout and 4 cases of inappropriate navigation. Furthermore, among inappropriate navigation, 3 were occurred in crossing situation, and 1 was occurred in restricted visibility situation. And all their reasons of imputation were mainly on cargo ships.

With plotting positions of collision on GIS map, it was found where collisions between cargo ship and fishing boat usually occur as shown on figure 2. Accidents mainly occurred in South Coast of Korea and Korea Strait (Tsushima Strait), each 8 and 9 cases. At the East of Kanmon Strait, 4 collisions occurred in Seto Inland Sea, only 1 happened in Kanmon Strait and Bungo Channel. In Korea Strait (Tsushima Strait), accidents usually occurred with driven fishing boat in crossing situation. Moreover, in Seto Inland Sea, collisions with fishing boats engaged in fishing mainly happened.

In case of the fishing vessel causing attributable to the collision, except for one case where all crew members lost their lives in an accident, all 5 cases were not related to fishing work: 4 cases of drowsiness and fatigue, and 1 case of toilet. Besides, among them 4 cases were occurred in crossing situation. In a case that named as 'E' on Figure 2, the cause of the collision was attributable to the unknown and sudden movement of the fishing boat to the cargo



ship side.

On the other hand, in a case when causes attributable were belonged to the Cargo ship, there were two accidents which vessels only sounds a whistle and did not take action in the crossing situation even they are give-way vessels. And the situation where the cargo ship did not comply with COLREG Rule 19 (Conduct of Vessels in Restricted Visibility) and the captain violate the duty of maneuver himself in the restricted visibility situation. In one case where the course continued to be maintained despite the crossing situation. Except them, all other 17 accidents occurred due to improper lookout of cargo ships.

COLREG rule 18 mentioned that in encounter situations with restricted ability in maneuvering vessels engaged in fishing, cargo ships should keep out of the way of fishing boats. Subsequently, the collision was concluded to be caused by cargo ships, and the main factor was an improper lookout. This improper lookout occurred because of the following causes; duty officers entered chart rooms, mistakes in the RADAR setting, and did not understand the target ship's course or status. In addition, collisions between anchored fishing boats and cargo ships are caused by the improper lookout of cargo ships under the same factor.

Most of the accidents did not say exactly why they could not find or grasp the situation, but four cases were caused by the officer on duty going to the chart room, one by the sleeping, one because of the wrong radar setting among the restricted visibility, and last one by drinking alcohol.

In addition, the cause of the improper lookout is not specified in 10 cases. However, eventually due to improper lookout, radar or visual observation was not thoroughly performed, thus factors such as not being able to find the other ship or equipment, not being able to grasp the status of the other ship, or not being able to grasp the risk of collision. Moreover, in each of the cargo and fishing boat, the captain left his lookout and duty to an unqualified person, to sleep, or empty the wheelhouse.

In the collision between a cargo ship and a fishing boat, the number of accidents occurring at night or on a restricted visibility were almost the same with the number of accidents occurring during the day. This is different with the collision between cargo ships which the number of accidents that occurred at night recorded nearly twice during the day.

Lastly, average gross ton of Cargo ship was 2,454(M/T). Their flags were 19 Korean, 3 Cambodian, 2 Panamanian, 1 Chinese, Vietnamese, Malaysian. Conversely, Fishing boats were 24.8(M/T) in average. 14 Japanese, 12 Korean, and 1 Chinese boat collided.

### 3.3 Cargo Ship – Cargo ship

Accidents between cargo ships are plotted on map with their encounter situation as shown on Figure 3.

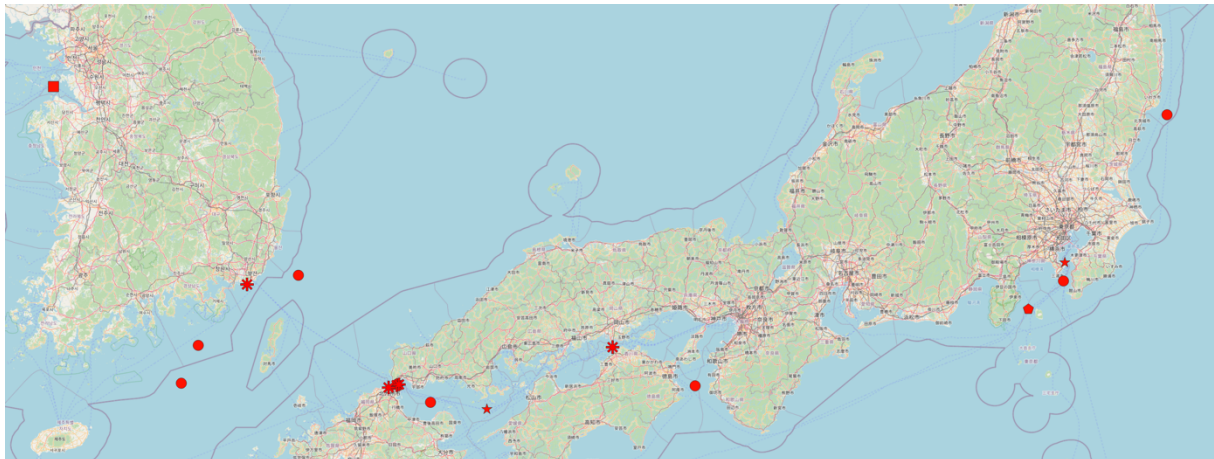


Figure 3. Hazard map of accidents between cargo ships (Korea and Japan)

With plotting positions of collision on map, it was able to find out where cargo ships collided. Those accidents usually happened in strait, channel, or inland sea. Especially, as shown on figure 3, Kanmon Straits, Seto Inland Sea, and Uruga channel were the main place of collisions. Unlike collisions between cargo ships and fishing boat, only few collisions occurred in Korea Strait and South Coast of Korea.

Initially, there were 16 collision accidents between cargo ships, and 3 cases were accidents between vessels who navigate between Korea and Japan. Accordingly, among 32 vessels related with collisions, 19 vessels were navigating between Korea and Japan. Except these 3 cases, reasons attributable to the collision were 9 cases for Korea-Japan ships and 4 cases for opponent ships. Secondly, when focus on the main factor of accidents, there

were 4 accidents caused by improper lookout, 7 accidents caused by inappropriate maneuvering, and 5 accidents caused by inappropriate navigation. Especially, in collision caused by inappropriate maneuvering, there was a problem of unreasonable entry and maneuvering or the misuse of VHF. Particularly, there was confusion due to unfamiliarity with the use of VHF, or failure to comply with the agreement through VHF, or to clearly understand the contents. At last, 7 collisions occurred in the Crossing situation, 5 in the local rule situation applied to each port or special sea area, 2 in overtaking, 1 in anchoring, and 1 in head-on.

Average gross tonnage of Korea – Japan Ships was 7136.7(M/T) and their flag was usually Korea. With 10 Korean flags, 2 Panamanian, 2 Cambodian, 1 Japanese, Marshall Island, Kiribatian, Sierra Leon, Singapore follow. In the other hand, average size of opponent vessel was 9691.4(M/T). Indeed, their flags were 5 Panama, 4 Japan, 2 Korea, 1 Philippine, and 1 Togo. There were 4 collisions occurred in daytime and 12 occurred in nighttime.

### 3.4 Cargo ship – Tugboat

Accidents between cargo ships and tugboats are plotted on map with their encounter situation as shown on Figure 4.

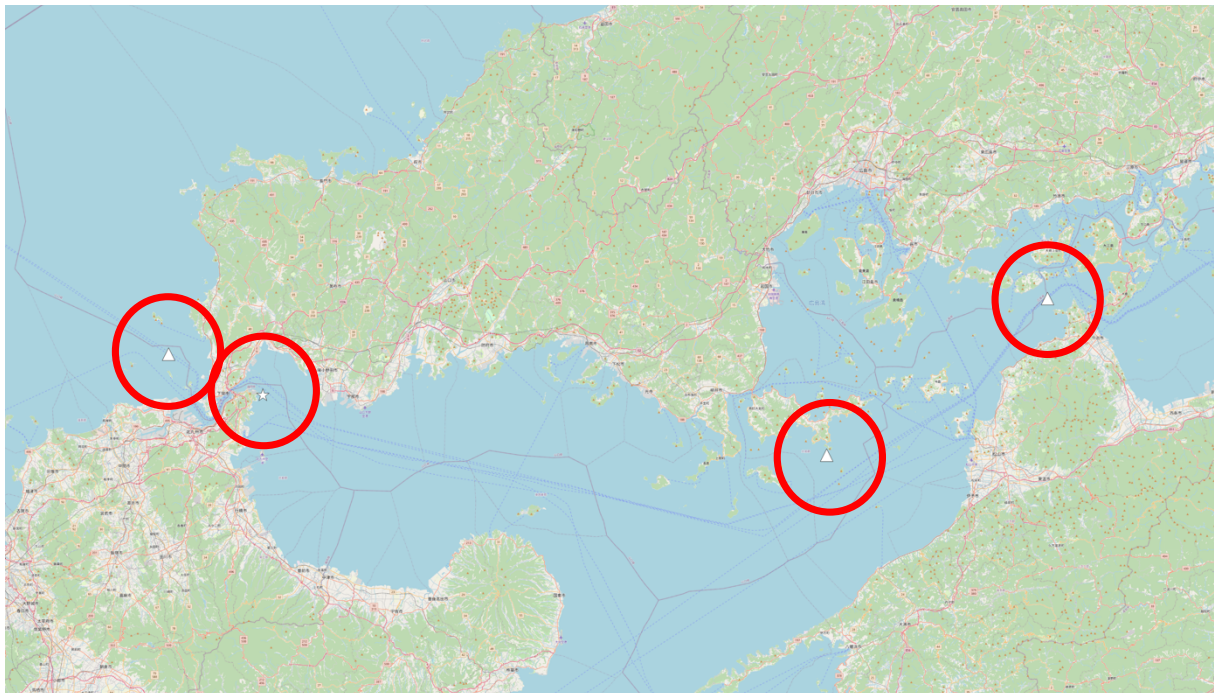


Figure 4. Hazard map of accidents between cargo ship and tugboat (Near Kanmon Strait and Seto Inland Sea)

There were 4 collisions (8.2%) between cargo ship and tugboat. All collisions occurred in Japanese territory sea and well-known congested sea area; 2 in Kanmon Strait, 2 in Seto Inland Sea. Besides, they happened because of the fault of Korea – Japan navigating vessels.

Firstly, 1 collision occurred when a cargo ship was trying to overtake tugboat, and this was caused because of inappropriate navigation. In this case, cargo ship didn't follow the COLREG, and the master of cargo ship didn't maneuver himself. In other cases, 3 accidents occurred between cargo ship and tugboat towing other material. In details, there were 2 cases that cargo ships didn't find a row of tugboats because of improper lookout. Conversely, 1 case exists because cargo ship misjudged and carried out inappropriate maneuvering to bow of tugboat. Therefore, all reasons of imputation were mainly on cargo ships who navigate between Korea and Japan.

Average gross ton of cargo ship was 3795(M/T) and tugboat was 143(M/T). Additionally, average length of towed material was 84.59m.

### 4. Consideration

Collisions between cargo ships – fishing boats, cargo ships – and cargo ships mainly occur in Korea - Japan route. In addition, as can be seen in the GIS hazard map, this route is a dangerous route that requires exhaustive watchkeeping in continues voyage that last for one or two days. Besides, it was confirmed that collisions between cargo ships and fishing boats occurred mainly in the Korean Strait and the southern coast of Korea, and collisions between cargo ships occurred in narrow channels such as the Kanmon Strait.

First of all, it was difficult to grasp in detail because improper lookout occurred because it is not written in verdict and report. However, In the case of cargo ships, not only the shorter navigation distance and the entire route are included in the risky sea area, but also irregular sleep caused by frequent entry and departure inevitably increases the fatigue of duty officers. Additionally, Nishizaki (2020) found that fatigue can affect the ability to perform watchkeeping, and Cho (2010) stated that sleep time and stress can affect to collision accident. Therefore, it can be inferred that ships navigating this route were also affected by the possibility of collision due to the route characteristics that cause fatigue. Furthermore, there were many cases in which OOW went into the chart room and did not concentrate on their duty. To prevent this, it can be said that each shipping company needs to come up with countermeasures to reduce the fatigue of on-call workers and entry into the hazard room.

Moreover, regarding accidents occurring between cargo ships, inappropriate maneuvering was the most common cause of the accident. In particular, the most frequent occurrence of this type of collision is the misuse of VHF. Several faults have occurred, such as using VHF when it is not necessary, not using it when it is necessary, or not following an agreement. Therefore, there is a need for countermeasures including VHF usage education and communication through radio.

In addition, Sun (2011) pointed out that in the case of fishing boats, low alertness, fatigue, and daily working hours are the main causes of drowsy operation. In the analysis results of this study, it was also found that sleep or fatigue of the fishing boat operator was the cause of the negligence of the fishing boat. As a result, cargo ships should always be aware of the possibility of sleeping operation status of fishing boats. Also, if necessary, cargo ships should avoid even they are a stand-on ship. Education for fishing boat that their low alertness and fatigue can cause drowsy operation and accident also needed.

Consequently, the actual situation and characteristics of Korea – Japan route can be suggested through this study. Initially, collision occurs throughout the entire route as shown in GIS hazard map. Especially, accidents between fishing boat and cargo ship usually occur in Korea Strait and South Sea of Korea. Also, fishing boats on this route may operate in drowsy condition due to fatigue. In contrast, there is a high risk of collision with cargo ships on Kanmon Straits. In addition, accidents related with cargo ships are mainly caused by the improper lookout and the misuse of VHF.

For the safe navigation in Korea – Japan shipping route, further research is needed.

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