BACHELOR THESIS & COLLOQUIUM – ME184841

RISK ASSESSMENT FOR BALLAST WATER MANAGEMENT WITH COMBINED ENVIRONMENTAL MATCHING AND SPECIES-SPECIFIC METHOD IN TANJUNG PERAK PORT, INDONESIA

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DOUBLE DEGREE PROGRAM
DEPARTMENT OF MARINE ENGINEERING
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SURABAYA
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PENILIAAN RISIKO UNTUK PENGELOLAAN AIR BALAS DENGAN MENGGAMBUNGKAN METODE *ENVIRONMENTAL MATCHING* DAN *SPECIES-SPECIFIC* DI PELABUHAN TANJUNG PERAK, INDONESIA

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APPROVAL FORM

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BACHELOR THESIS

Submitted to Comply One of the Requirements to Obtain Bachelor Engineering Degree

on

Marine Operational and Maintenance (MOM)
Bachelor Program Department of Marine Engineering
Faculty of Marine Technology
Institut Teknologi Sepuluh Nopermber

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DECLARATION OF HONOR

I hereby who signed below declare that:

This bachelor thesis has written and developed independently without any plagiarism act. All contents and ideas drawn directly from internal and external sources are indicated such as cited sources, literatures and other professional sources.

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Department	: Marine Engineering

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Surabaya, July 2019

Nur Fauzan Hawari

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ABSTRACT

The ballast water management convention (BWMC) has been entered into force since 8th September 2017. International Maritime Organization (IMO) concerns to the ballast water from vessels that could harm the environment. Consequently, IMO adopted BWMC to regulate ballast water discharge. To support the implementation of this regulation, ballast water management risk assessment was developed. Ballast water management risk assessment is a tool to identify risk factors that have the potential to cause harm. This analysis will conduct to identify the ballast water content from the vessel with international routes, assess the risk level of ballast water, decide the options and consequences of ballast water management, and develop the software application for assessing the risk of ballast water. The result of this research are 8 donor ports is assessed with Intermediate risk level and 29 donor ports are assessed as high level. Ballast water management risk assessment software application is recommended to assess the risk level of vessels. Moreover, this software application gives solution to the port state control office whether the vessel is rejected to come or not. Not only that, but this application also can be installed on a smartphone so that user can access this software from anywhere easily.

Keywords: Risk Assessment Ballast Water, Software Application.

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PENILIAAN RISIKO UNTUK PENGELOLAAN AIR BALAS DENGAN MENGGAMBUNGKAN METODE *ENVIRONMENTAL MATCHING* DAN *SPECIES-SPECIFIC* DI PELABUHAN TANJUNG PERAK, INDONESIA

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ABSTRAK

Konvensi pengelolaan air balas sudah diberlakukan sejak 8 September 2017. Organisasi Internasional Maritim (IMO) mengawatirkan pembuangan air balas pada kapal yang dapat mencemari lingkungan. Sebagai akibatnya, IMO menyetujui konvensi air balas untuk mengatur pembuangan air balas. Untuk mendukung penerapan peraturan ini, makan penilaian risiko untuk pengelolaan air balas dikembangkan. Penilaian risiko terhadap pengelolaan air balas merupakan sebuah alat untuk mengidentifikasi faktor-faktor risiko yang memiliki potensi untuk menyebabkan kerusakan lingkungan. Analisis ini akan dilakukan untuk mengidentifikasi konten air balas dari kapal dengan pelayaran internasional, menilai risiko dari air balas, menentukan pilihan dan konsekuensi dari pengelolaan air balas, serta mengembangkan perangkat lunak untuk menilai risiko air balas. Hasil dari karya tulis ini adalah 8 pelabuhan memiliki risiko menengah dan 29 pelabuhan memiliki risiko tinggi. Aplikasi perangkat lunak untuk menilai risiko pengelolaan air balas sangat direkomendasikan untuk menilai tingkat bahaya dari kapal-kapal. Terlebih lagi, aplikasi perangkat lunak ini memberikan solusi kepada pengguna untuk menentukan apakah kapal ditolak untuk datang ke pelabuhan atau tidak. Tidak hanya itu, aplikasi ini juga dapat dipasang di telepon seluler pintar sehingga pengguna dapat mengakses aplikasi ini dimanapun.

Kata kunci: Penilaian risiko air balas, Perangkat lunak, Aplikasi

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PREFACE

In the name of Allah, the Most Gracious, the Most Merciful. All praises to Allah SWT, the Lord Of The Creation, and countless greetings of peace and blessing upon the Noble Messenger of Allah, the Last Prophet, Prophet Muhammad SAW. With the deepest sense of gratitude and humility, I praise and thank Allah for granting me the guidance and opportunity of the unique service of finishing this thesis research. Thesis has been written to fulfill the graduation requirements and achieve Bachelor of Engineering (S.T., B.Eng.) Degrees on Marine Engineering Department, Faculty of Marine Technology Institut Teknologi Sepuluh Nopember and Hochschule Wismar.

The authors would like to say thanks for those who helped the author in the making of the thesis.

1. Writer's beloved parents, who always give prayer and support to the writer.
2. Dr. Eng. Trika Pitana, ST., M.Sc. as Head of Marine Operation and Maintenance Laboratory and writer's Supervisor.
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7. Ahmad Adyarso Wibowo and Yudhistira Maksum, who always gave support and advice to the writer.
8. Padma Sindura, who always listened the writer's problem.
9. All of Musholla An-Nur committee who always gave the writer dish during holy month of Ramadhan.
10. All of writer's friends who have graduated from ITS.
11. All writer's fellows in Marine Engineering batch 2015 who were struggling together for four years.

The writer concerns in the imperfections of this thesis. Therefore, any criticisms and suggestions that are built from the reader will be expected. The author hopes this thesis provides benefits primarily for readers and additional for the author in the process of teaching and learning.

Surabaya, July 2019

Author

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CHAPTER I
INTRODUCTION

1.1. Background

Ballast water is truly needed when a vessel is not fully loaded because ballast water can provide stability during vessel is on a voyage or doing loading and unloading process. Vessels use ballast water because water is the easiest material to get and it is free to obtain. Moreover, it is also easy to adjust the volume of water that we need. However, the discharge of ballast water can lead to environmental threats.

In 2004, the Ballast Water Management Convention (BWMC) was adopted by the International Maritime Organization (IMO). It proposes to stop the spread of pathogen microorganisms from one region to another. In addition, the transfer of pathogen microorganisms through the ballast water is considered as a major ecological threat to the oceans (Karahalios, 2017).

November 5th, 2015, Indonesia became the latest country to ratify the Ballast Water Management Convention (BWMC). The International Convention for the control and management of ships ballast water and sediment's 2004 is authorized by Peraturan Presiden No. 132 Tahun 2015. Indonesia had experienced ballast water problems in Teluk Lampung in 2012. At that time, many sudden species of dead fish were discovered. After tracing, the cause of the problem is the invasion of pathogen organisms from outside Indonesian waters. For this reason, Indonesia ratified that regulation (Arif, et al., 2016).

Recently, ship visits continue to increase, especially ships with international routes. For instances, Tanjung Perak port has increased ship visits by 7% compared to the previous year. In 2018, Tanjung Perak port has a total visit of 14,109 units. Whereas in 2017, the port of Tanjung Perak received a total of 13,163 visits (Widarti, 2018). Consequently, the probability of discarded ballast water will increase and HAOP (Harmful Aquatic Organism Pathogen) also will increase. It means, the environmental around Tanjung Perak port may be damaged because of HAOP.

From the information above so risk assessment should be done to know the risk level of ballast water discharged from the foreign vessel which come to the port of Tanjung Perak. Risk assessment is a tool to identify hazards and risk factors that have the potential to cause harm. It can be also used to analyze and evaluate the risk associated with that hazard. The most important, the purpose of using risk assessment is to improve the safety at some objects, such as, vessel, port, and equipment (Dasgupta, 2017). According to BWMC (Ballast Water Management Convention), risk assessment is the most recently agreed global tool for bio invasion (David & Gollasch, 2018).

The aim of this study is to make the risk assessment of ballast water at port of Tanjung Perak, Surabaya, Indonesia. From the risk assessment later, we will know the risk level of ballast water discharge from foreign vessel. The author chooses the port of Tanjung Perak as a location for research because the port of Tanjung Perak is an international port so that many vessels from abroad, such as, Malaysia, Singapore, China, etc. will be berthing there. Consequently, they potentially bring harmful aquatic organism and pathogen or have high risk of ballast water discharge. In addition, the port of Tanjung Perak is close to residential areas, so harmful aquatic organisms might have damage to the local people.

The final result of this study is a software application that can assess the risk of ballast water. Software application will be very helpful for the port officer because it can complete their task in a simple and fast way. Port officer also can do their task in everywhere because the software application is portable. So, they don't have to do their task in office.

1.2. Problem of Analysis

Based on the background that described above, author raised the following problem, there are:

1. How to identify the ballast water discharge content?
2. How to make the risk assessment of ballast water at Port of Surabaya?
3. How to decide the options and consequence of ballast water management?
4. How to develop the software application for assessing the risk of ballast water?

1.3. Scope of Problem

The limitations of this thesis are:

1. Analysis will be done at Port of Tanjung Perak, Surabaya
2. Analysis will be done at terminals which accept ships from other countries
3. Vessels analyzed only vessel with international routes

1.4. Objectives

The objectives to be achieved from this thesis are:

1. To know the ballast water content, such as, salinity, human pathogen, and harmful algae from vessels with international routes which come to the port of Tanjung Perak, Surabaya.
2. To assess the risk level of ballast water discharge from vessels with international routes that will berth at port of Surabaya.
3. To decide the options and consequences of ballast water management.
4. To develop the software application for assessing the risk of ballast water.

1.5. Benefit

The benefits of this thesis are as follows;

1. Obtaining information about ballast water content from foreign vessel which will berth at port of Tanjung Perak.
2. Giving information to the public about risk of ballast water that contained harmful aquatic organism pathogen (HAOP)
3. As a reference to the implementation of Ballast Water Management Convention in Indonesia.
4. To help port officer deciding whether ships from another port is proper to de-ballasting or not.

1.6. Systematics of Writing

The systematics of writing in this thesis are:

a. CHAPTER 1. INTRODUCTION
In this chapter the author explains the background of the problem as main idea to do the research, the formulation of the problem, the objectives to be achieved in the research, the benefits for the public, the limitation of the research, and systematics of writing.

b. CHAPTER 2. LITERATURE REVIEWS
In this chapter the author explains the basic theories that support the study of risk assessment of ballast water

c. CHAPTER 3. METHODOLOGY
In this chapter the author describes and explains the flow chart steps in conducting this research task that is arranged systematically.

d. CHAPTER 4. DATA ANALYSIS
In this chapter the author describes about, the data collection, data analysis, the results of risk assessment, ballast water management options and consequences, developing software application, and working principle of software application.

e. CHAPTER 5. CONCLUSION AND SUGGESTION
In this chapter the author writes the conclusions based on the goals to be achieved in this final project, as well as provide development advice for further research

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CHAPTER II
LITERATURE STUDY

2.1. Ballast Water System on Vessel

Ballast is a substance or material used to support stability. Ballasts can be used in solid or liquid form, but the most commonly used and easy to obtain is water. Ballast water will be used when a ship is doing loading and unloading process at the port. Ballast system is generally seawater which is pumped into the ballast tank. The ballast tank is placed on the double bottom or wing tanks. Process water ballast divide into two ballasting (filling ballast water) and de-ballasting (ballast water discharge). In some literature and common practice mentioned that weight water ballast overall ranged between 10%-15% of the displacement of the ship.

Figure 2.1 shows the process of ballast water system. The working principle of this system is very simple, where pumps are used to pump seawater from sea chest box and moved into water ballast tanks into stability completed. At this time, the pathogen microorganism also come to the ballast tank. Then to de-ballasting, the

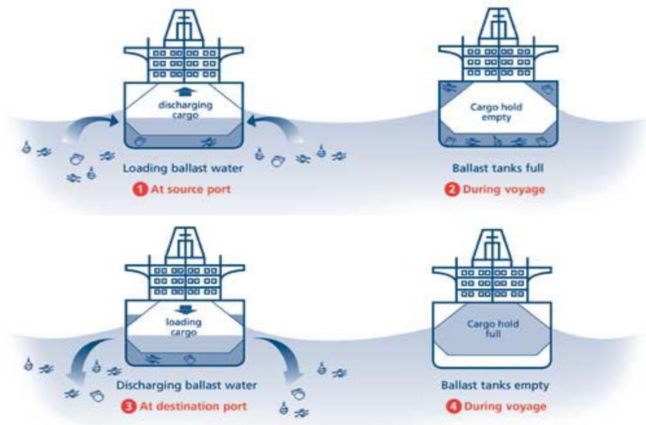

Figure 2. 1. Ballast System Process
Source: (IMO, 2017)

seawater in water ballast tanks will be pumped by ballast pump through he overboard (O/B). At the moment, the pathogen microorganism inside ballast tank will come out to the environmental. System design ballasts intimately connected with the process of loading and unloading in ports, especially the time it takes to load the unloaded, and also directly affect the change of displacement of the ship.

2.2. Regulation about Ballast Water

The International Maritime Organization (IMO) has realized that ballast water carried from different waters can bring disaster or disease to the marine ecosystems because discarded ballast water may contain Invasive Aquatic Species and Harmful Aquatic Organisms. In February 13th, 2014, IMO adopted the Ballast Water Management Convention (BWMC), the purpose is to keep the marine ecosystems from harmful aquatic organisms which are come from one region to another, by implementing the standards and procedures for the management and control of ships' ballast water and sediments. However, the convention entered into force in 8th September 2017. It takes a long time because to enter the force because it was dependent on enough ratifications by states. Moreover, the suitable ballast water management systems were not available and guidelines to support the BWM convention needed to be developed (IMO, 2017). At this time, there are 60 countries including Indonesia which ratified

This convention has 5 sections which regulate ballast water management, those sections are from Annex A until Annex E. So, this is explanation about Annex A to Annex E:

a. Annex A

The concentration of this section is on general provisions includes definitions, application and exemptions. Ballast water under the regulation A-2 the general applicability is “Except where expressly provided otherwise, the discharge of Ballast Water shall only be conducted through Ballast Water Management, in accordance with the provisions of this Annex.”

b. Annex B

The concentration of this section is on management and control requirements for ships. This part has 4 regulations which are B-1 to B-4. B-1 expresses that ships are required to have on board and implementation a ballast water management plant and approved by the administration. B-2 states that ships must have a ballast water record book to record the process of ballast water in a ship. B-3 contains about the specific requirement of ballast water management. And B-4 regulates about ballast water exchange.

c. Annex C

The concentration of this section is on additional measures on ballast water to prevent, reduce, or eliminate the transfer of harmful aquatic organisms and pathogen through ships’ ballast water and sediment. The party should communicate their intention to establish additional measure to the organization least in 6 months, except in emergency, prior to the projected date of implementation of the measure.

d. Annex D

The concentration of this section is on standards for ballast water management. There are 2 standards on this section:

- D1

The D-1 standard requires ships to exchange their ballast water in open seas, away from coastal areas. Ideally, this means at least 200 nautical miles from land and in water at least 200 meters deep. By doing this, fewer organisms will survive and so ships will be less likely to introduce potentially harmful species when they release the ballast water.

- D2

The D-2 standard specifies the maximum number of viable organisms allowed to be discharged, including specified indicator microbes harmful to human health.

This section also states that new ships built on or after 8th September 2017 must meet the D2 standard. For existing ship which is built prior to 8th September 2017 must meet the D1 standard until their D2 compliance date. In September 8th, 2024, all ships must meet D2 standard.

The D-2 standard states that ships meeting the requirements of the BWM Convention shall discharge:

- Toxigenic Vibrio cholerae (serotypes O1 and O139) with less than 1 Colony Forming Unit (cfu) per 100 milliliters or less than 1 cfu per 1 gram (wet weight) of zooplankton samples,
- Escherichia coli less than 250 cfu per 100 milliliters, and
- Intestinal Enterococci less than 100 cfu per 100 milliliters.

All ships also must have:

1. Ballast water management plan
2. Ballast water record book
3. International Ballast-Water Management Certificate

e. Annex E

The concentration of this section is on survey and certification requirements for ballast water management. This part gives requirements for initial renewal, annual, intermediate and renewal surveys and certification requirements. Appendices give form of Ballast Water Management Certificate and Form of Ballast Water Record Book.

2.3. Human Pathogen

Pathogen is an infectious microorganism, such as, virus, bacterium, protozoa, etc. Pathogen Microorganism may create hazard to the marine environment, human health, property or resources (IMO, 2017). Expert estimates that there are about 7,000 different species are moved every day around the globe by ships (Carlton, 2001).

Human pathogens were here defined as microbes or microorganisms (virus, bacterium, prion, or fungus) that cause a disease in humans. It should be noted that many human pathogens are difficult to identify in water. Therefore, IMO suggested to use "indicator microbes" such as *Escherichia coli* and *Enterococci* and to limit their acceptable numbers in ballast water discharges. Although these indicator microbes themselves are usually harmless, natural mutations may result in human diseases, as recently shown by a strain of bacteria known as enterohaemorrhagic *E. coli* (EHEC), a natural mutation of *E. coli*. Further, the presence of elevated numbers of human faecal bacteria like *E. coli* and *Enterococci* in water indicates an improper wastewater treatment system and the water may consequently also include other more problematic species such as disease agents. IMO further includes the toxic strains of *Vibrio cholerae,* the agent of the Cholera disease (Matej David, 2015)

2.4. Target Species

Target species are a selection of species whose invasiveness in the examined area is likely and was confirmed in other areas. For a target list of unwanted organisms, fundamental selection criteria must be defined. Based upon the IMO definition in the G7 Guidelines, at least all following factors need to be considered when identifying target species:

- evidence of prior introduction, i.e., thereby the species shows its capability to become introduced outside its native range;
- potential impact on environment, economy, human health, property or resources;
- strength and type of ecological interactions, i.e., severeness of its impact;
- current distribution within the biogeographic region and in other biogeographic regions; and
- relationship with ballast water as a vector, i.e., when the species was already found in a ballast tank or if the life cycle of the species include a larval phase which makes a ballast water transport likely.

A problem is subjectivity with the target species selection. It may occur that the assessment whether or not a species should become a target species will result with a degree of uncertainty associated with the approach. It is possible that species identified as harmful in some environments may not be harmful in others and vice versa.

Even when a target species has been reported, although its establishment status and abundance may be unknown, from the donor and recipient ports, its continued introduction into the recipient port(s) may increase the probability that it will become established and to cause negative impacts. This is especially the case when the target species occurs in higher abundance in the donor port compared to the recipient port (Matej David, 2015).

2.5. Toxic Algae

Algae are a diverse group of aquatic organisms that have the ability to conduct photosynthesis. However, there exist certain algal species that need to obtain their nutrition solely from outside sources; that is, they are heterotrophic (Vidyasagar, 2016). When colonies of algae that live in the sea and freshwater grow out of control, it will damage to marine ecosystem such as fish killing. This phenomenon is called as Harmful Algae Bloom (HAB). HABs are usually caused by non-toxic algae rather than toxic algae. For example, the non-toxic algae *Skeletonema costatum* is one of the most common red-tide organisms to cause harmful blooms in the coastal waters of china, as well as many others, such as, Tokyo Bay, Swedish coast, and Black Sea coast of Romania (Shi, et al., 2012).

Toxic algae are group of algae that can produce toxins. This toxic caused illness to human. Particularly in the tropics people are often harassed by diseases and syndromes due to consumption of seafood contaminated by algal toxins. Some of these diseases may be fatal. There is currently no international record of the number of incidents of human intoxication caused by contaminated seafood. There are five

Figure 2. 2. Variety of species found in ballast water
Source: (Matej David, 2015)

human syndromes are presently recognized to be caused by consumption of contaminated seafood (UNESCO, 2019):

1. Amnestic Shellfish Poisoning (ASP)
   This syndrome can be life-threatening. It is caused by domoic acid that accumulates in shellfish, but the disease can apparently also be fish borne, so the risk to humans may be more serious than previously believed. It is characterized by gastrointestinal and neurological disorders including loss of memory. During blooms of species of the diatom *Pseudonitzschia* should be controlled because this species produces ASP.

2. Ciguatera Fish Poisoning (CFP)
   This poisoning, transmitted by several tropical reef fish, is generally not lethal, although fatalities have been documented. Ciguatera produces gastrointestinal, neurological and cardiovascular disturbances, and recovery often takes months or even years.

3. Diarrhetic Shellfish Poisoning (DSP)
   This is a wide spread type of shellfish poisoning which causes gastrointestinal disturbances with diarrhea, vomiting, and abdominal cramps. If is not fatal, and the patients usually recover within a few days. Chronic exposure to DSP is suspected to promote tumor formation in the digestive system.

4. Neurotoxic Shellfish Poisoning (NSP)
   Until recently this syndrome has been restricted to the Gulf of Mexico, but in 1993 it was reported also from New Zealand. It is characterized by gastrointestinal and neurological disturbances usually with recovery within a few days. Toxic aerosols formed by wave action may cause asthma-like symptoms.

5. Paralytic Shellfish Poisoning (PSP)
   This is a life-threatening syndrome with neurological effects. The is no known antidote to PSP. Each year about 2000 cases of PSP are reported with 15 % mortality.

Figure 2.2 represents some examples of organisms which were found in ballast water samples. Ballast water may contain 30 to 100 phytoplankton species including those being potentially toxic or harmful (Matej David, 2015). There are so many of phytoplankton species which is able to bring disaster to the marine environment, such as, *Pseudonitzschia delicatissima, Dinophysis acuminata, Dinophysis caudata, Scrippsiella, trochoidea, Salmonella.*

a. *Pseudonitzschia delicatissima*

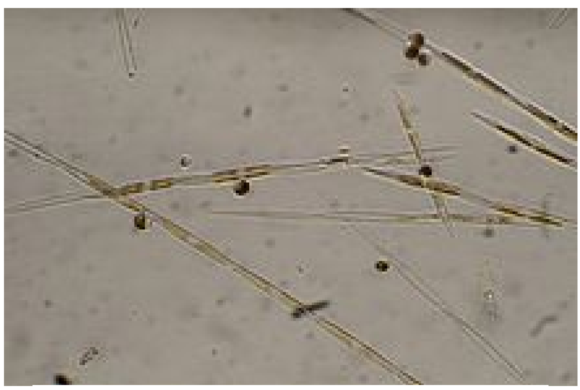

Figure 2. 3. Pseudonitzschia delicatissima
Source: (WORMS, 2017)

Pseudonitzschia delicatissimais a marine which is usually found in Atlantic Ocean, Spitsbergen, and Sweden. Recently, it was found in Chinese port because of ballast water discharge from another countries. Pseudonitzschia delicatissima was published by Heiden, H. & Kolbe, R.W in 1928. This species is categorized as harmful aquatic species because it can cause diseases and death in many marine creatures, as well as the humans who consume them.

b. Dinophysis acuminata

Figure 2. 4. Dinophysis acuminate
Source: (WORMS, 2017)

Dinophysis acuminate is a marine species that is published by Claparède and Lachmann in 1859. This species is usually found in in coastal waters of the north Atlantic and Pacific oceans. *Dinophysis acuminate* is harmful aquatic organism because it brings disease to the marine environment. *Dinophysis acuminate* can produce okadaic acid causing diarrhetic shellfish poisoning (DSP) (Gulledge, 2002).

c. Dinophysis caudata

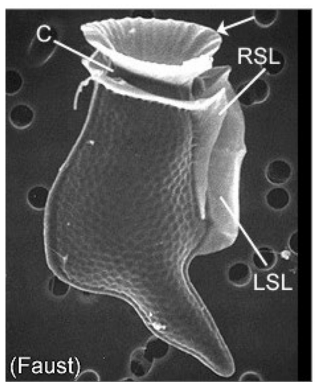

Figure 2. 5. Dinophysis caudata
Source: (WORMS, 2017)

Dinophysis caudata is a marine species that is usually found in Adriatic Sea. This species was published in 1881 by W.S. Kent. *Dinophysis caudata* is harmful aquatic species because they can produce red tides resulting in fish mortality. Recently, *Dinophysis caudata* is also invasive alien species because it was found in Chinese port because of ballast water discharge from another countries

d. *Scrippsiella trochoidea*

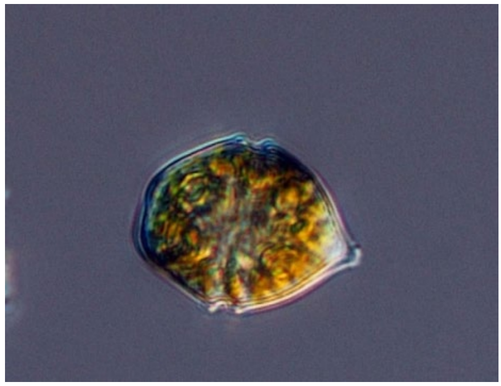

Figure 2. 6. Scrippsiella trochoidea
Source: (WORMS, 2017)

Scrippsiella trochoidea is a marine species which is usually found in neritic and estuarine as its habitat. This species was published in 1976 by A.R. Loeblich III. *Scrippsiella trochoidea* is categorized as harmful aquatic species because it can bring disease to the environment and human health if it is consumed by human. For instance, this species causes water discoloration.

e. *Salmonella*

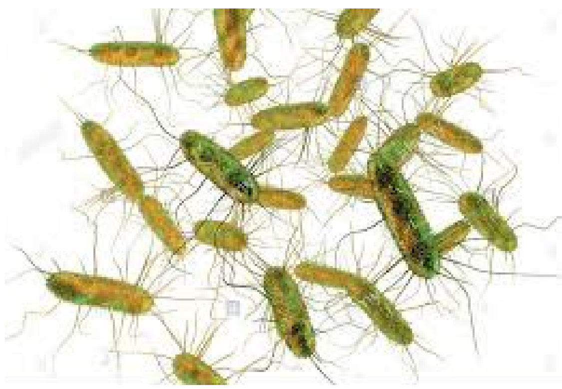

Figure 2. 7. Salmonella
Source: (WORMS, 2017)

Salmonella was found in 1880 by Karl in the Peyer's patches and spleens of typhoid patients. *Salmonella* is pathogens microorganism which can bring disease to the human. *Salmonella* usually is found in contaminated foods with the feces of animals or humans carrying the bacteria. If this pathogen is consumed by human, it causes disease in the digestive organs, such as, diarrhea, fever, stomach cramps. Foods that are most likely to contain *Salmonella* include raw or undercooked eggs, raw milk, contaminated water, and raw or undercooked meats.

2.6. Ballast Water Management System on Vessel

Table 2. 1. BWMS Technologies

	Treatment			
Pre-treatment	Chemical	Physical	Biological	Residual control
Filtration	Chlorination	UV radiation	Bioaugmentation with microorganisms	Chemical reduction (Neutralisation)
Hydrocyclone	Electrochlorination	Deoxygenation		
Coagulation	Ozonation	Inert gas or Nitrogen injection		
Flocculation	Chlorine dioxide	Ultrasonic treatment		
	Peracetic acid	Cavitation		
	Other active substances	Fine filtration		
		Heat		

Source: *(Matej David, 2015)*

The ballast water management system is a sufficient solution to comply with the rules of ballast water management convention. The purpose of using a ballast water management system is to reduce the amount of harmful aquatic organism pathogens (HAOP) and Invasive Alien Species (IAS) contained in ballast water so as not to pollute the recipient port's water. There are various types of ballast water management systems that have been applied on the ship as shown in Table 2.1.

Based on **Table 2.1**. Ballast water management system is decided into 3 stages namely, pre-treatment, treatment, and residual control. Pre-treatment is a process that has a purpose to exclude as much as possible solid material and bigger organisms. This stage consists of 4 types those are, filtration, hydrocyclone, coagulation, and flocculation. Treatment stage have a purpose to make the last process more effective for example, the use of UV in this process can kill the rest of the remaining organisms that are still alive when they have passed the pre-treatment stage. This stage is divided into 3 types those are chemical, physical, dan biological. The last stage is residual control, it is needed if there are any substances left in the ballast water after the treatment process is completed that could cause harm when being discharged from a vessel, e.g., residual toxicity from the use of active substances and their by-products (Matej David, 2015).

In the following paragraphs we describe some of the main working principles of BWMS components:

a. Filtration

Filtration is a common system which is usually installed on board as ballast water management system. The function of this system is to separate marine organisms and suspend solid materials from the ballast water using sediments. This system uses screen or discs as filters to effectively remove suspended solid particles from the ballast water with automatic backwashing. The advantage of this system is, it is very effective for removing suspended solid particles of larger size by using screen filtration. Conversely, this system is not very handy in removing particles and organisms of smaller sizes (Raunek, 2017)

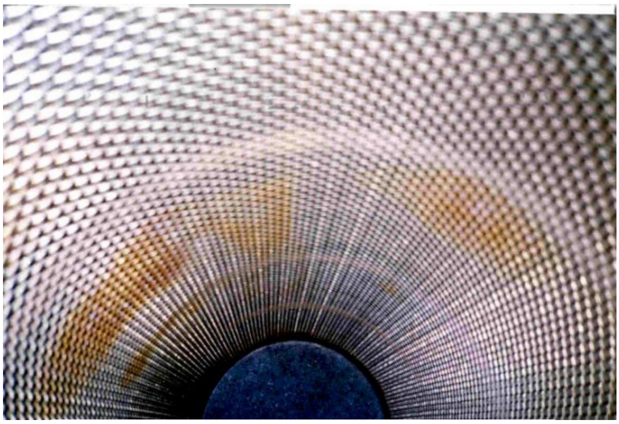

Figure 2. 8. Screen Filter
Source: (Raunek, 2017)

b. Hydrocyclone

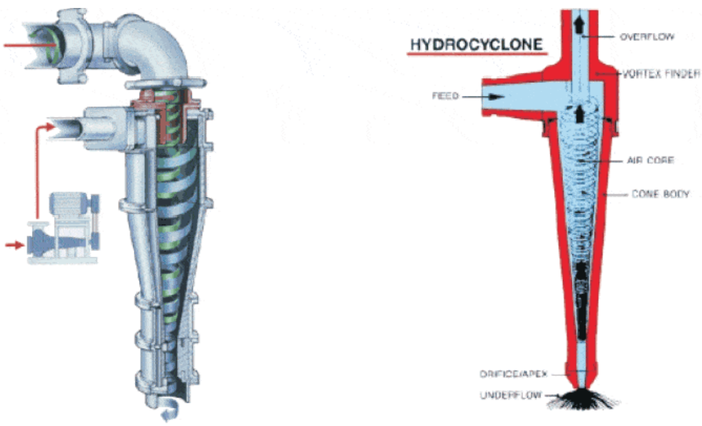

Figure 2. 9. Hydrocyclone
Source: (Raunek, 2017)

Hydrocyclone is one of effective system for separating suspended solids from the ballast water. This system has high velocity force to rotate the water to separate solids. Centrifugal force of hydrocyclone tosses particles heavier than the water to the perimeter of the separation chamber. As a consequence, solids gently drop along the perimeter and end up in the calm collection chamber of the separator. It also does not have a moving part, so it will be easy to maintain, operate, and install on board ship (Raunek, 2017). Moreover, Hydrocyclone has been proposed as a relatively uncomplicated and reasonable way of removing larger particles and organisms from ballast water (Matej David, 2015).

c. Ultraviolet

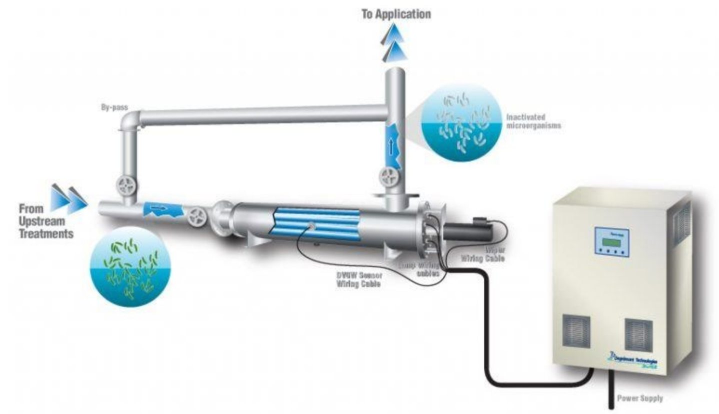

Figure 2. 10. Ultraviolet System
Source: (Raunek, 2017)

Ultraviolet ballast water treatment has been used globally for water filtration purpose and sufficient against a broad range of organism. Ultraviolet is usually used for sterilizing waste water and also for purification in aquaculture and fisheries. This method consists of ultraviolet lamp which produce ultraviolet rays which acts on the DNA of the organism and make them harmless and prevent their reproduction (Raunek, 2017). Ultraviolet systems are suitable for any vessel in theory, such as, ro-ro vessels, container ships, offshore supply vessels and ferries. The advantages of this system are it easy to install, and it has few safety concerns. It also operates independently, no matter what the water salinity and temperature are (DNVGL, 2016). However, the UV effect on organisms is not immediately so that compliance with the D-2 standard is difficult to show when the water is treated during discharge (Matej David, 2015).

2.7. Previous Research

Risk assessment of ballast water management has been studied in several port in the world. For instance, risk assessment of ballast water management has been done in port of Koper, Slovenia. The author chose port of Koper as place to do the study because the Adriatic Sea is one of the waters with a dense shipping routes and there are many ports from various European countries.

The previous research used environmental matching method and species-specific method as material to finish the risk assessment process. Actually, there are 2 parameters when we use environmental matching method those are temperature and salinity. Nevertheless, the author of previous research only use salinity as parameter because salinity is not fluctuating as strongly as temperature (David & Gollasch, 2018).

In the following paragraphs the author identified 4 routes which come to the port of Koper as recipient port:

a. Piraeus (Greece) to Koper (Slovenia)

Port of Piraeus is located in Mediterranean Sea. However, the salinity of this port is also above 30 PSU. Consequently, the author should do the species-specific method to know the risk level. According to this study, port of Piraeus is assessed as very high situation because the presence of human pathogen and the indicator of microbes above the D-2 level.

b. Reni (Ukraine) to Koper (Slovenia)

Different from previous port that has been mentioned, port of Reni is located on the left bank of the Danube River, Odessa Oblast, Ukraine. However, vessels from Reni sometimes come to the port of Koper, for this reason the author chose this case to be identified. Reni is a freshwater port with salinity above 0.5 PSU which is different with salinity of Koper. Conforming to this study, port of Reni is assessed as low level because of the salinity difference.

c. Trieste (Italy) to Koper (Slovenia)

Table 2. 2. Comparison Species of Trieste Port and Koper Port

Species	Trieste	Koper
Alexandrium insuetum		X
Alexandrium minutum	X	X
Alexandrium minutum/tamutum		X
Alexandrium pacificum	X	
Alexandrium pseudogonyaulax	X	X
Alexandrium sp. *various N.I. group*		X
Alexandrium spp.		X
Alexandrium tamarense/catenella		X
Alexandrium tamarense complex		X
Dinophysis caudata	X	X
Dinophysis fortii	X	X
Dinophysis hastata		X
Dinophysis sacculus	X	X
Dinophysis spp.		X
Dinophysis tripos	X	X
Gonyaulax polygramma	X	
Gonyaulax spinifera	X	X
Lingulodinium polyedrum	X	X
Noctiluca scintillans	X	X
Phalacroma mitra	X	X
Phalacroma rotundatum	X	X
Prorocentrum cordatum	X	X
Prorocentrum lima		X
Protoceratium reticulatum	X	X
Pseudo-nitzschia cf. calliantha		X
Pseudo-nitzschia galaxiae	X	
Pseudo-nitzschia multistrata	X	X
Pseudo-nitzschia sp. 1		X
Pseudo-nitzschia spp.		X

Source: *(David & Gollasch, 2018)*

Port of Trieste is also located in Adriatic Sea as if port of Koper. Port of Trieste has salinity above 30 PSU (Practical Salinity Unit) which means the author should do the next step that is species-specific method in order to know the risk level. According to David and Gollasch the people who did the research, port of Trieste is categorized as very high level because the indicator of microbes above the D-2 level and there are target species in donor port

d. Bar (Montenegro) to Koper (Slovenia)

Different with case above, port of Bar is located in Adriatic Sea and has salinity above 30 PSU. Because the salinity of both ports is comparable so that the species-specific method was carried out. Port of Bar is assessed as very high risk situation because the indicator of microbes above the D-2 level.

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CHAPTER III
METHODOLOGY

This chapter provides the adopted methodology for doing the study. Methodology shows the basic framework of stages to finish the study. The methodology of this study involves all of the activity that support the completion of this study. The stages of this methodology are shown in **Figure 3.**1 and **Figure 3.2.**

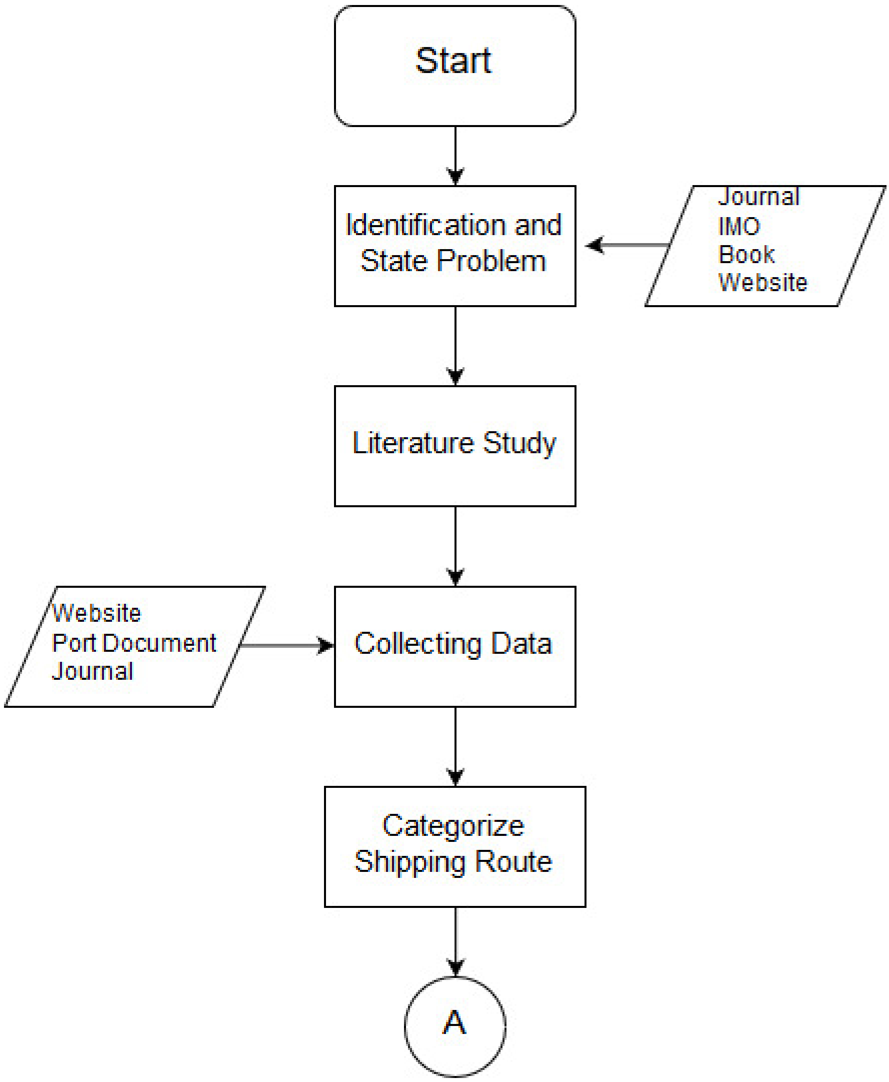


Figure 3. 1. Methodology part 1

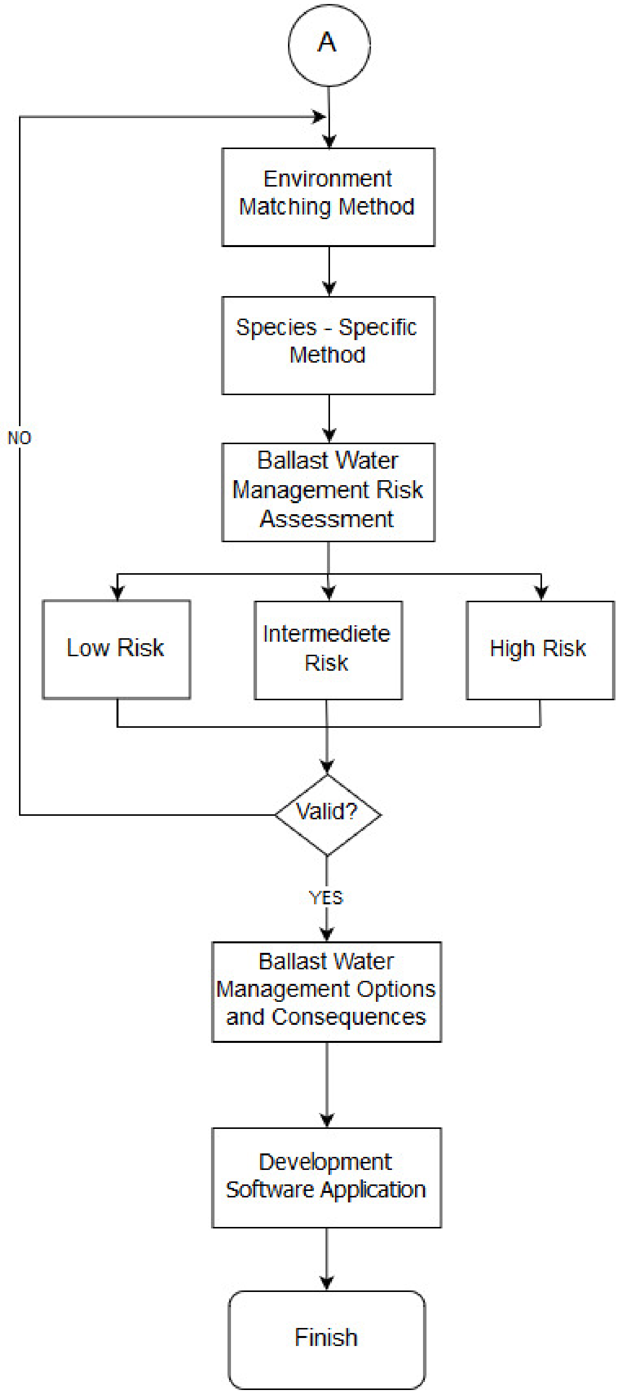


Figure 3. 2. Methodology part 2

3.1. Identification and State Problem

In this step, the problem is identified from many sources, such as, journal, IMO, book, website etc. Those sources support the background of writing this study. The selection of problem, objective and predicted solution shall be arranged. As a result, the objective and benefit of the study could be achieved. The author suspects that with the increase of foreign ships entering and deballasting in the Surabaya port, the environment around the port can be damaged due to HAOP carried by foreign vessels. By using this risk assessment method, it will be easier to assess the risk level of vessels which enter the port.

3.2. Literature Study

After identifying the problem, the literature study should be done. This will be the reason in solving the problem. The literature study was done by reading some sources of information. There are books, journals and other thesis which came from the trusted sources. The aim of this step is to explain the depth of review, summarize the basic theory, general and specific reference, and obtaining various other supporting information related to the study. In this study, the author involves a literature study on ballast water system, regulation about ballast water, pathogens microorganism content, ballast water management system, and previous research for risk assessment of ballast water management.

3.3. Collecting Data

At this stage, collecting data is very necessary for the continuation of this research. The data needed to do this research are:

1. The report of vessels with international route that have berthed at port of Tanjung Perak.
2. Origin port of foreign vessel.
3. Salinity from donor port and recipient port.
4. The information of Ecoregion from donor port and recipient port.
5. The information of HAOP (Harmful Aquatic Organisms Pathogen) from donor port and recipient port.

The data mentioned above can be obtained through websites, journals, and from recipient ports.

3.4. Processing and Analysis the Data

After getting the data above, the next step is to process and analyze the data with the following steps:

1. Grouping vessel data according to the origin port.
2. Sorting the data from the origin port that often visits until it seldom visits the port of Tanjung Perak.
3. Comparing the salinity’s information of the origin port and recipient port.
4. Comparing the ecoregion’s information of the origin port and recipient port.

5. Analyzing the HAOP (Harmful Aquatic Organisms Pathogen) information.
6. Doing the risk assessment.

3.5. Ballast Water Management Risk Assessment

At this stage, the risk assessment is divided into 3 levels, namely: low level, intermediate level, and high level. The explanation for these sections will be explained in the paragraph below.

a. High Level
   The water ballast is categorized as high level when one of the lights is fulfilled, the conditions are; the presence of toxic algae in donor port, the presence of human pathogen in donor port, the presence of HAO from donor port in recipient port.

b. Intermediate Level
   The water ballast is categorized as intermediate level when one of the lights is fulfilled, the conditions are; there is no needed data for risk assessment reliable, the absence of HAO from donor port in recipient port.

c. Low Level
   The water ballast is categorized as low level when one of the lights is fulfilled, the conditions are; the absence of HAOP from donor port, the difference of salinity between donor port and recipient port. For example, if the recipient port has salinity above 30 PSU so the salinity of donor port should be below 0.5 PSU. Otherwise, if the recipient port has salinity below 0.5 PSU so the salinity of donor port should be above 30 PSU.

3.6. Validation

In this step, the author will check the validation of the study. If the study is not valid so the author should repeat the processing and analysis step. Otherwise, if the study is valid so the author can do the next step which is developing software application.

3.7. Ballast Water Management Options and Consequences

At this stage, the author will decide the best ballast water management options and consequences for vessels which will berth at Surabaya port. The BWM options and consequences will also be adjusted to the regulations that have been implemented so that it will be relevant to the current situation.

3.8. Development Software Application

After doing those steps above, the author will develop software application that can determine the risk of ballast water from the origin port. To develop this software application, first we have to build the database as source of the data and design the website. Second, that website will be converted into android application.

CHAPTER IV
DATA ANALYSIS

4.1. Data Collection

Table 4. 1. List of Vessels which Came to Recipient Port

SHIP NAME	ORIGIN PORT	RECEIPENT PORT
LYDIA	YUKUHASI, JEPANG	TPS
E.R. MONTPELLIER	YANTAN, CHINA	TPS
RUBINA SCHULTE	YANTAN, CHINA	TPS
GH ZONDA	YANTAN, CHINA	TPS
DORIS RUBY	YANGON, MYANMAR	JAMRUD
SHANNON PROSPER	YANGON, MYANMAR	JAMRUD
GOLDEN 138	YANGON, MYANMAR	JAMRUD
GLOBAL SEA	XIAMEN, CHINA	JAMRUD
ROYAL PESCADORES	XIAMEN, CHINA	JAMRUD
TRUONG MINH VICTORY	XIAMEN, CHINA	JAMRUD

The data needed for risk assessment ballast water management is the origin port of vessels that have once berthed in port of Tanjung Perak. The author got the data from port of Tanjung Perak especially from Teluk Lamong Terminal, Jamrud Terminal, and Peti Kemas Surabaya Terminal (Zaman, et al., 2019). Those terminals can accept vessels from aboard. The data is got by the author is from 2012 until 2018. The list of origin port can be seen in **Table 4.1**.

Table 4. 2. List of Origin Ports

Port Code	Source Port	Country	Ships Call
SGSIN	SINAGPORE	SINGAPORE	617
TWKHH	KAOHSIUNG	TAIWAN	534
MYTPP	TANJUNG PELEPAS	MALAYSIA	298
TLDIL	DILI	TIMOR LESTE	268
CNSHG	SHANGHAI	CHINA	110
MYPKG	KELANG	MALAYSIA	110
KRPUS	BUSAN	KOREA	89
HKHKG	HONG KONG	HONG KONG	69
MYWSP	WESTPORT	MALAYSIA	57
CNSHK	SHEKOU	CHINA	26

Actually, the total of vessels that have once berthed in Tanjung Perak are 10.021 ships call. But vessels that have berthed and discharged the ballast are 2.332

ships call. After categorizing those data base on port origin, there are 37 ports or shipping line from aboard.

4.2. Data Analysis

After the data needed is found, the risk assessment process starts with an environmental matching method of salinity difference, then followed by different species-specific risk assessment.

In **Figure 4.1** shows the enhanced model of ballast water management risk assessment (David & Gollasch, 2018). There will be three different risk level from that model, such as, low risk, intermediate risk, and high risk. The yellow box area is the environmental matching risk assessment process, in the green box area is the species-specific risk assessment process.

The risk assessment will result in a high risk in conditions when:

- The ballast water is from a donor port that contains human pathogens;
- The ballast water is from a donor port that contains indicator microbes is above the D-2 standard;
- The ballast water is from a donor port that contains target species;
- The ballast water is from a donor port that contains toxic algae that are potentially in a bloom state;
- The ballast water is from a donor port that contains HAO which are already also existence in the recipient port.

The discharge of ballast water will be assumed as posing an intermediate risk in conditions when:

- There is no reliable data about environmental matching or species-specific method in the donor port;
- The ballast water is from a donor port that contains indicator microbes meet the D-2 standard;
- The ballast water is from donor port that contains toxic algae which are not in the bloom sate in the donor port during ballast water uptake;
- The ballast water from a donor port that contains HAO which are not existence in the recipient port.

The risk assessment will result in a low risk in condition when:

- If the salinity of donor port (i.e. >30 psu) and recipient port (i.e. <0.5 psu) has a significant difference or vice versa.
- The ballast water is from donor port that does not contains HAOP and is from the same region as the recipient port.

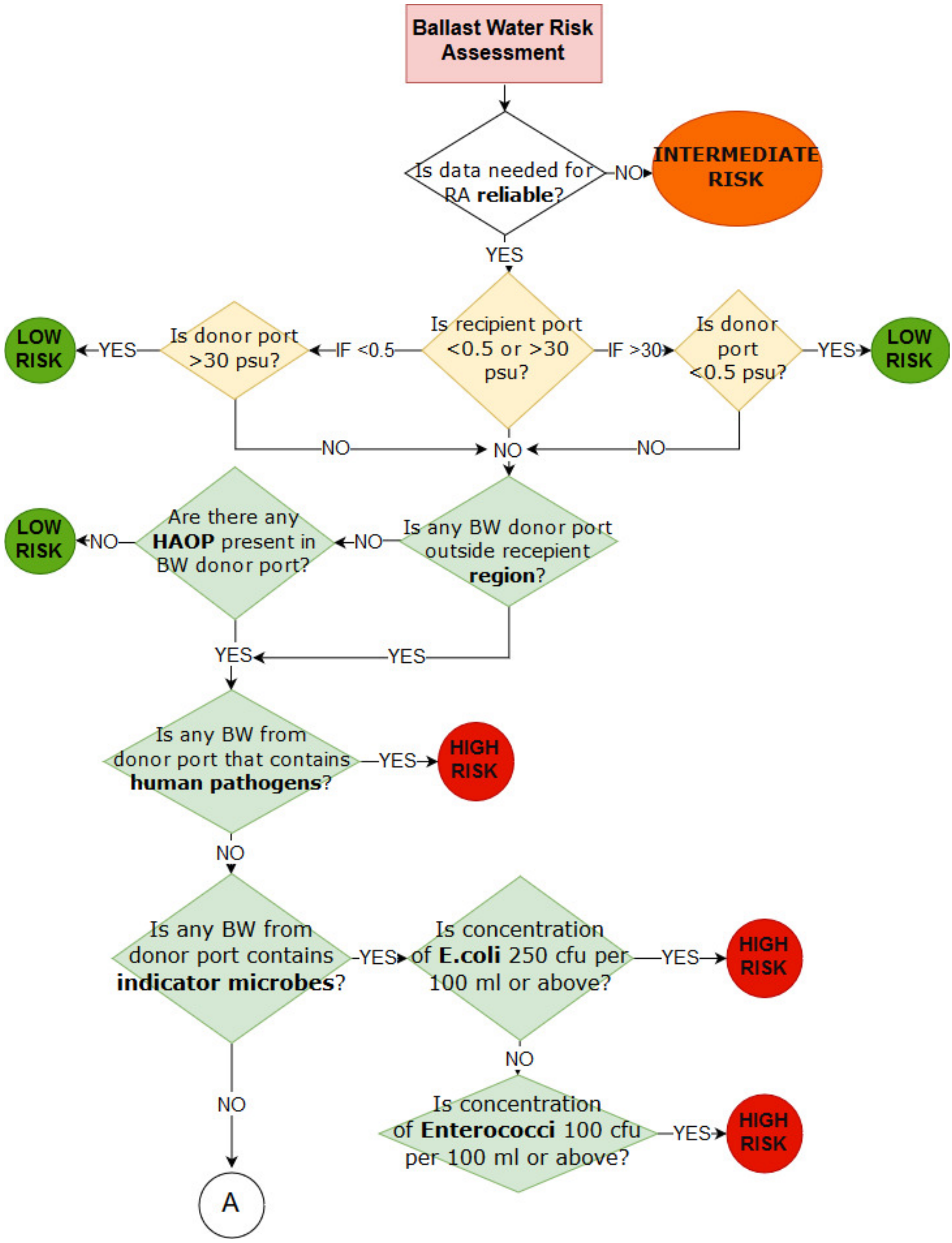


Figure 4. 1. Flow Chart BWM Risk Assessment (enhanced) part 1
Source: *(David & Gollasch, 2018)*

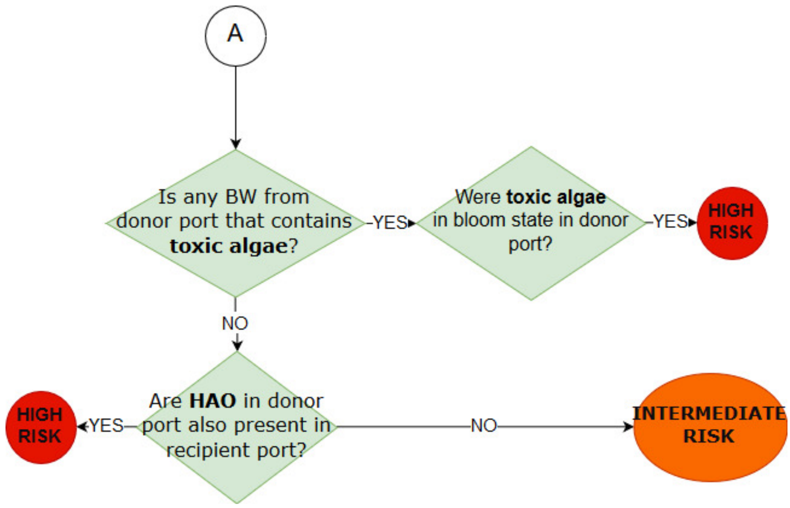


Figure 4. 2. Flow Chart BWM Risk Assessment (enhanced) part 2
Source: *(David & Gollasch, 2018)*

4.2.1. Environmental Matching Method

The environmental matching method uses environmental parameter namely salinity. We use salinity as parameter for environmental matching method because the change of salinity is not fluctuating as strongly as temperature. In addition, salinity also is the only parameter common to all risk assessments study that have been done before (David & Gollasch, 2018).

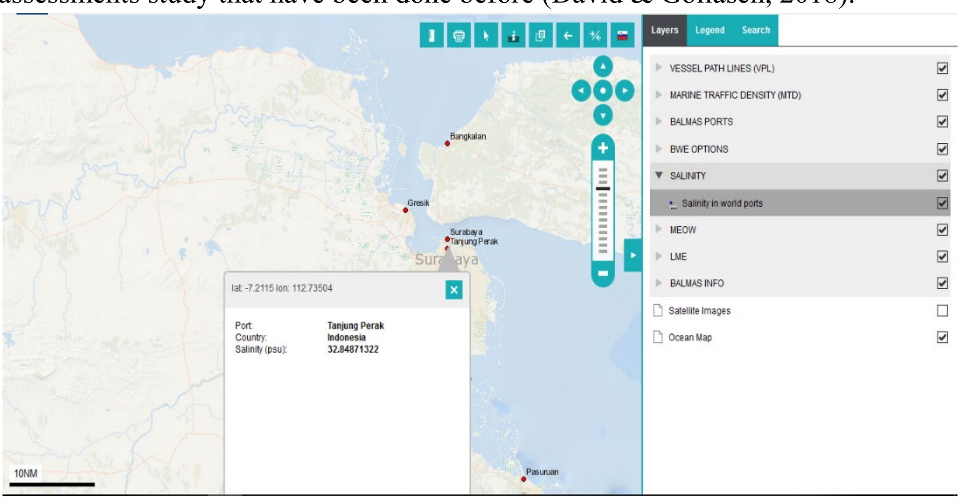


Figure 4. 3. BALMAS GIS Database for Salinity

To get the salinity of every donor ports, we can use the BALMAS GIS database (https://www.balmas.eu/balmas-tools/balmas-gis). It contains more than 7800 world ports with their salinities. The view of BALMAS GIS can be seen in **Figure 4.3**.

Table 4. 3. Donor Ports Salinity

Source Port	Country	Salinity (PSU)
SINAGPORE	SINGAPORE	38.67
KAOHSIUNG	TAIWAN	35.25
TANJUNG PELEPAS	MALAYSIA	30.28
DILI	TIMOR LESTE	34.24
SHANGHAI	CHINA	1.5
KELANG	MALAYSIA	32.19
BUSAN	KOREA	34.76
HONG KONG	HONG KONG	25.71
WESTPORT	MALAYSIA	32.19
SHEKOU	CHINA	29.23

The Salinity of Tanjung Perak Port is 32.84 psu (practical salinity unit). The risk assessment will result in a low risk if the salinity of donor port is below the 0.5 psu. In reality, there are no donor ports with salinity below 0.5 PSU. It means, we will not assess the donor ports in low risk. Port of Davao has the highest salinity with 38.73 PSU. For the lowest salinity is owned by Port of Ho Chi Minh with 1.15 PSU. The data of every donor ports salinity can be seen in APPENDIX I.

4.2.2. Species-Specific Method

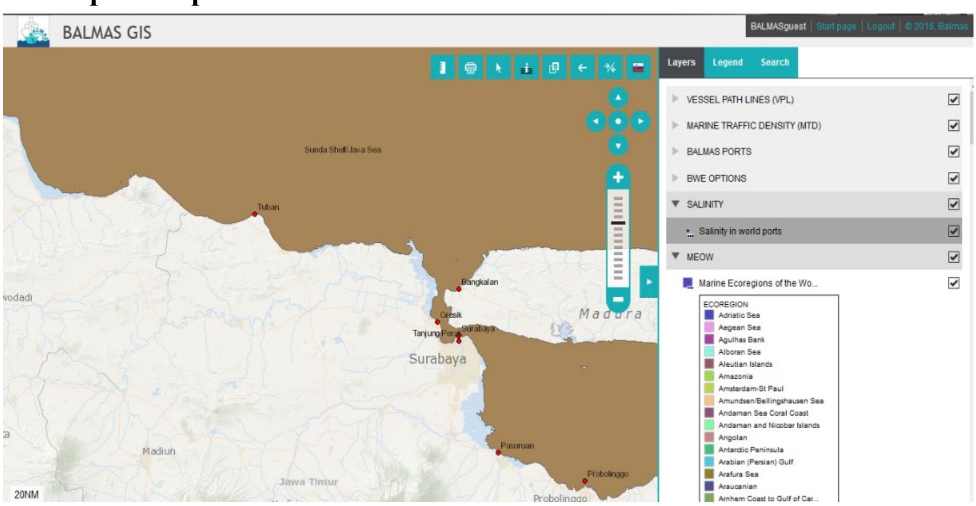


Figure 4. 4. BALMAS GIS Database for Ecoregion

The identification of species-specific method takes into account the potential of each selected species to become invasive and the potential harm that it may be able to cause in a new environment (David & Gollasch, 2018).

Table 4. 4. Donor Ports Ecoregion

Source Port	Country	Ecoregion
SINAGPORE	SINGAPORE	Malacca Strait
KAOHSIUNG	TAIWAN	Southern China
TANJUNG PELEPAS	MALAYSIA	Malacca Strait
DILI	TIMOR LESTE	Lesser Sunda
SHANGHAI	CHINA	East China Sea
KELANG	MALAYSIA	Malacca Strait
BUSAN	KOREA	East China Sea
HONG KONG	HONG KONG	Southern China
WESTPORT	MALAYSIA	Malacca Strait
SHEKOU	CHINA	Southern China

To use species-specific method, first we have to answer a question from **Figure 4.1** that is “is any Ballast Water donor port outside recipient region?” To know the region of recipient port and donor port, we can also use BALMAS GIS data base as seen in **Figure 4.4**. Port of Tanjung Perak as recipient port is located on Java Sea. From the data that we can see in APPENDIX I, all of donor ports are located outside the Java Sea. Then, the answer of the question above is “No” because there are no donor ports that are inside the Java Sea.

To know whether aquatic organism is harmful or not, we use different data source i.e., the online BALMAS HAOP database (https://www.balmas.eu/balmas-tools/balmas-haop-database), IOC-UNESCO Taxonomic Reference List of Harmful Micro Algae database (http://www.marinespecies.org/hab/), and a journal that explain about toxic algae and harmful algae (Ignatiades & Gotsis-Skretas, 2010).

4.3. Result

4.3.1. Singapore (Singapore) to Surabaya (Indonesia)

The port of Singapore's salinity is same as with Surabaya port that is above 30 PSU. So, we have to do the next step which is species-specific risk assessment. The port of Singapore is located on Malacca Strait so to answer the question "Is any BW donor port outside the receptor region?" The answer is "Yes". This port contains human pathogens such as *Vibrio parahaemolyticus* which can cause gastroenteritis in humans. So, to answer the question "Is any BW from a donor port that contains human pathogens?" is "Yes". Even though this port is in accordance with the IMO standard for ballast water management, it contains *E. coli* under 250 cfu / 100 ml. But the water in this port contains *Enterococci* which is above the D-2 IMO standard which is more than 100 cfu / 100 ml (Ng, et al., 2017).

In summary, for Singapore to Indonesia, the presence of human pathogens, indicator microbes above the D-2 results in a high risk.

4.3.2. Nansha (China) to Surabaya (Indonesia)

Both ports, Nansha and Surabaya, have similar salinity conditions (above 30 PSU). Because the salinity of both ports is comparable so that the species-specific RA was carried out. We have searched scientific literature and Internet sources for human pathogen revealed that this port contains *vibrio spp* above 1 cfu / 100 ml (D-2 IMO Standard). Moreover, the number of concentration *Enterococ*cus also above 100 cfu / 100 ml. However, this port is in accordance with the IMO standard for ballast water management, it contains *E. coli* under 250 cfu / 100 ml (Siang, et al., 2018).

In summary, for Nansha to Surabaya, the presence of human pathogens, indicator microbes with concentrations above the D-2 standard results in a high risk situation.

4.3.3. Kaohsiung (Taiwan) to Surabaya (Indonesia)

Port of Kaohsiung is located on South China Sea. The salinity of this port is 35.25 PSU, so that a species specific BWM RA was conducted. An internet search reveals a human pathogen which is *Vibrio parahaemolyticus* (Lin, et al., 2015). In addition, the number concentration of *Enterococcus* from this port is 114 cfu / 100 ml which is above the D-2 standard (Siang, et al., 2018). However, the concentration of *E. coli* meets the regulatory standard (Chen, 2017).

In summary, for Kaohsiung to Surabaya, the presence of human pathogens and *Enterococcus* with concentrations above the D-2 standard results in a high risk situation.

4.3.4. Tanjung Pelepas (Malaysia) to Surabaya (Indonesia)

Tanjung Pelepas is one of the biggest ports in Malaysia. This port is located on Malacca strait and have 30.28 PSU, so that a species specific BWM RA was conducted. An internet search reveals that there are human pathogens in this port which is *Vibrio parahaemolyticus*. *Vibrio parahaemolyticus* usually causes gastrointestinal illness in human. The concentration of *Vibrio spp* is also above the D-2 Standard which is 71.4 cfu / 100 ml (high tide) and 80 cfu / 100 ml (low tide). However, the concentration of *E. coli* and *Enterococci* are below the D-2 standard (IMO, 2015).

In summary, for Tanjung Pelepas to Surabaya, the presence of human pathogens results in a high risk situation.

4.3.5. Pasir Gudang (Malaysia) to Surabaya (Indonesia)

The salinity of Pasir Gudang and Surabaya is comparable (above 30 PSU) so that the species-specific risk assessment carried out. We have searched scientific literature and internet sources for human pathogen. The result, this port contains human pathogen *Vibrio alginolyticus*. *Vibrio alginolyticus* was first identified as a pathogen of humans in 1973. It occasionally causes eye, ear, otitis and wound infections. In the research also says that *Vibrio spp* and *E. coli* are above the D-2 standard. For *Vibrio spp* the concentration is 1.6 cfu / 100 ml (low tide) and 9.8 cfu / 100 ml (high tide).

For *E. coli* the concentration is 224 cfu / 100 ml (low tide) and 332 cfu / 100 ml (high tide). However, the concentration of *Enterococci* meets the regulation (IMO, 2015).

In summary, for Pasir Gudang to Surabaya, the presence of human pathogens and *E. Coli* with concentrations above the D-2 standard results in a high risk situation.

4.3.6. Kelang (Malaysia) to Surabaya (Indonesia)

Kelang port's salinity is same as Surabaya which is above 30 PSU. So, we have to do the next step which is species-specific risk assessment. The port of Kelang is located Malacca Strait so to answer the question "Is any BW donor port outside the receptor region?" The answer is "Yes". Based on internet research, this port contains human pathogen (*Vibrio spp*) and E*nterococcus* which are above the D-2 standard. Concentration for *Vibrio spp* is above 300 cfu / 100 ml. For *Enterococcus* is 170 cfu / 100 ml. However, the concentration of *E. coli* meets the regulation which is 13 cfu / 100 ml. Very (Siang, et al., 2018).

In summary, for Kelang to Surabaya, the presence of human pathogens and *E. Coli* with concentrations above the D-2 standard results in a high risk situation.

4.3.7. Shanghai (China) to Surabaya (Indonesia)

Both ports, Shanghai and Surabaya have different salinity conditions. Shanghai has salinity above 30 PSU but it is not below the 0.5 PSU. Consequently, we have to do the next step for better result of the assessment. Based on scientific literature, the result reveals that there is no human pathogen and indicator microbes like *E. coli* and *Enterococci* (Wu, et al., 2017). So, to answer the question "Is any BW from a donor port that contains human pathogens?" and "Is any BW from donor port that contains indicator microbes?" The answer is "No". Internet sources also don't reveal any target species on this port. However, a journal says that this area has toxic algae which produce Diarrhetic Shellfish Poisoning (DSP) by *Scapharca subcrenata* Although, this port has toxic algae but it was not blooming on this area (Wang & Wu, 2009).

In summary, for Shanghai to Surabaya, the presence of toxic algae on this port leads to intermediate risk situation.

4.3.8. Ningbo (China) to Surabaya (Indonesia)

Port of Ningbo is located on East China Sea. The salinity of this port is 22.03 PSU. Although Ningbo port and Surabaya port have a different salinity but the salinity of Ningbo port is not below 0.5 PSU, so species specific BWM RA was conducted. Based on scientific literature and internet sources, there are human pathogens, such as, *Pseudomonas sp, Staphylococcus sp, Vibrio sp, Legionella sp* in Ningbo port (Wu, et al., 2017). So, to answer the question "Is any BW from a donor port that contains human pathogens?" The answer is "Yes".

In summary, for Ningbo to Surabaya, the presence of human pathogens results in a high risk situation.

4.3.9. Xiamen (China) to Surabaya (Indonesia)

Both ports, Xiamen and Surabaya, have similar salinity conditions (above 30 PSU). Because the salinity of both ports is comparable so that the species-specific RA was carried out. We have searched scientific literature and Internet sources for human pathogen showed that there are human pathogens, such as, *Vibrio cholerae, Vibrio parahaemolyticus* (Wu, et al., 2017). So, to answer the question "Is any BW from a donor port that contains human pathogens?" The answer is “Yes”.

In summary, for Xiamen to Surabaya, the presence of human pathogens results in a high risk situation.

4.3.10. Penang (Malaysia) to Surabaya (Indonesia)

Penang port is located on Northern Bay of Bengal. The salinity of this port is 36.46 PSU. Because Penang port and Surabaya port have same condition (above 30 PSU), so species specific BWM RA was conducted. Based on scientific literature and internet sources, this port contains *vibrio spp* (human pathogen) which is above the standard. A journal article says that Penang port contains above 300 cfu / 100 ml of *vibrio spp*. This port also indicator microbes such as *E. Coli* and *Enterococcus*. The concentration for *E. Coli* is 15 cfu / 100 ml (meets the regulation) and *Enterococcus* is 166 cfu / 100 ml (Siang, et al., 2018).

In summary, for Penang to Surabaya, the presence of human pathogens and *Enterococcus* with concentrations above the D-2 standard results in a high risk situation.

4.3.11. Yantian (China) to Surabaya (Indonesia)

Yantian port's salinity is same as Surabaya which is above 30 PSU. So, we have to do the next step which is species-specific risk assessment. The port of Yantian is located on South China Sea so to answer the question "Is any BW donor port outside the receptor region?" The answer is "Yes”. Based on internet research, this port contains human pathogens, such as, *Vibrio cholerae, Vibrio mimicus, Vibrio metschnikovi, Vibrio damsela, Vibrio flurialis, Vibrio fluvialis, Vibrio alginolyticus, Vibrio parahaemolyticus, Vibrio vulnificus, Vibrio carchariae,* and *Plesiomonas shigelloide* (Wu, et al., 2017). So, to answer the question "Is any BW from a donor port that contains human pathogens?" The answer is “Yes”.

In summary, for Yantian to Surabaya, the presence of human pathogens results in a high risk situation.

4.3.12. Qingdao (China) to Surabaya (Indonesia)

The port of Qingdao's salinity is same as with Surabaya port that is above 30 PSU. So, we have to do the next step which is species-specific risk assessment. The port of Qingdao is located on Yellow Sea so to answer the question "Is any BW donor port outside the receptor region?" The answer is "Yes". We have searched internet source, the result revealed that this port contains human pathogens, such as, *Vibrio alginolyticus, Vibrio vulnifucus, Vibrio parahaemolyticus* (Wu, et al., 2017). In fact, port of Qingdao contains *Vibrio spp* which are above the D-2 standard. The concentration of *Vibrio spp* in this port is 63 cfu / 100 ml. Scientific literature also says that Qingdao port contains *Enterococcus* but the concentration meets the regulation. The concentration of *E. Coli* in this port is 0 cfu / 100 ml which is very (Siang, et al., 2018). In addition, a journal article shows that Yellow Sea contains target species which is *Rapana Venosa*. *Rapana Venosa* is a large-sized Japanese snail or the Asian Gastropod (David & Gollasch, 2010). Not only that, Qingdao port also contains others target species, such as, *Heterosigma akashiwo, Mesodinium rubrum and Skeletonema costatum* (Yuan & Yu, 2011).

In summary, for Qingdao to Surabaya, the presence of human pathogens and target species results in a high risk situation.

4.3.13. Dalian (China) to Surabaya (Indonesia)

The port of Dalian's salinity is same as with Surabaya port that is above 30 PSU. So, we have to do the next step which is species-specific risk assessment. The port of Dalian is located on Yellow Sea. Based on internet sources, this port does not contain human pathogen and indicator microbes (Wu, et al., 2017). However, this port contains target species, such as, *Rapana Venosa* (David & Gollasch, 2010). Not only that, Dalian port also contains others target species, such as, *Skeletonema costatum, Chaetoceros affinis, Thalassiosira nordenskÖldii, Noctiluca scintinllans, Exuviaella marina, Alexandrium catenella Chattonella marina* (Yuan & Yu, 2011). Because Dalian port is located on Yellow Sea, so it also contains *Rapana Venosa* as target species (David & Gollasch, 2010).

In summary, for Dalian to Surabaya, the presence of target species results in a high risk situation.

4.3.14. Hong Kong (Hong Kong) to Surabaya (Indonesia)

Port of Hong Kong is located on South China Sea. The salinity of this port is 25.71 PSU. Although Hong Kong port and Surabaya port have a different salinity but the salinity of Hong Kong port is not below 0.5 PSU, so species specific BWM RA was conducted. Based on scientific literature and internet sources, this port contains *Vibrio spp* (human pathogen) which is above the standard. A journal article says that Hong Kong port contains more than 300 cfu / 100 ml of *Vibrio spp*. This port also indicator microbes such as *E. Coli* and *Enterococcus* but it meets the regulation. The concentration for *E. Coli* is 12 cfu / 100 ml and *Enterococcus* is 60 cfu / 100 ml (Siang, et al., 2018).

In summary, for Hong Kong to Surabaya, the presence of human pathogen which is above the D-2 standard results in a high risk situation.

4.3.15. Manila North (Philippines) to Surabaya (Indonesia)

Both ports, Manila and Surabaya have different salinity conditions (above 30 PSU). Manila North has salinity above 30 PSU but it is not below the 0.5 PSU. Consequently, we have to do the next step for better result of the assessment. Based on scientific literature, the result reveals that there is no human pathogen and indicator microbes like *E. coli* nor *Enterococci*. Internet sources also don't reveal any target species on this port. However, a journal says that this area has toxic algae such as *Pyrodinium bahanense. Pyrodinium bahanense* produces saxitoxin and other toxin derivatives that cause Paralytic Shellfish Poisoning (Furio, et al., 2011). Moreover, that toxic algae also bloomed in donor port. Philippines has the greatest number of bloom outbreaks and affected areas with highest number of PSP cases recorded (Fukuyo, et al., 2011)

In summary, for Manila North to Surabaya, the presence of toxic algae which is blooming in donor port results in a high risk situation.

4.3.16. Subic Bay (Philippines) to Surabaya (Indonesia)

The salinity of Subic Bay and Surabaya is comparable (above 30 PSU) so that the species-specific risk assessment carried out. We have searched scientific literature and internet sources for human pathogen, indicator microbes, and target species. However, there are no result about it. A journal article says that Subic Bay contains toxic algae which is blooming in donor port. Those toxic algae are *Coscinodiscus spp., Nitzschia spp., Pseudo-nitzschia spp., Ceratium spp., Ceratium furca, Gonyaulax spp., Gymnodinium spp., Dinophysis caudate, Linguludinium spp., Phalacroma spp., Prorocentrum micans, Prorocentrum spp* (Austero & Azanza, 2018).

In summary, for Subic Bay to Surabaya, the presence of toxic algae which is blooming in donor port results in a high risk situation.

4.3.17. Westport (Malaysia) to Surabaya (Indonesia)

Westport port's salinity is same as Surabaya port which is above 30 PSU. So, we have to do the next step which is species-specific risk assessment. The port of Westport is located in the Malacca Strait so to answer the question "Is any BW donor port outside the receptor region?" The answer is "Yes". Based on internet research, this port contains human pathogen (*Vibrio spp*) and *Enterococcus* which are above the D-2 standard. Concentration for *Vibrio spp* is above 300 cfu / 100 ml. For *Enterococcus* is 170 cfu / 100 ml. However, the concentration of *E. coli* meets the regulation which is 13 cfu / 100 ml (Siang, et al., 2018).

In summary, for Westport to Surabaya, the presence of human pathogens and *E. Coli* with concentrations above the D-2 standard results in a high risk situation.

4.3.18. Busan (Korea) to Surabaya (Indonesia)

The port of Busan's salinity is same as with Surabaya port that is above 30 PSU. So, we have to do the next step which is species-specific risk assessment. The port of Busan is located on East China Sea so to answer the question "Is any BW donor port outside the receptor region?" The answer is "Yes". We have searched scientific literature and internet sources for human pathogen, indicator microbes, and target species. However, there are no result about it. A journal reveals that *Cochlodinium polykrikoides* exists on this port. *Cochlodinium polykrikoides* is a Dinoflagellate which produces toxic (toxic algae). This toxic alga can cause fish killing. In 2007, *Cochlodinium polykrikoides* was blooming on Busan port. However, in 2009, a sharp decrease in *Cochlodinium polykrikoides* blooms occurred. The sharp decrease in *Cochlodinium polykrikoides* blooms in 2009. Then, in 2011 no blooms were recorded (Lee, et al., 2013).

In summary, for Busan to Surabaya, the presence of toxic algae which is not blooming in donor port leads to intermediate risk situation.

4.3.19. Davao (Philippines) to Surabaya (Indonesia)

Both ports, Davao and Surabaya, have similar salinity conditions (above 30 PSU). Because the salinity of both ports is comparable so that the species-specific RA was carried out. Internet search reveals there is no report about human pathogen, indicator microbes, and target species. However, in April 2019, there is report that say Davao port was indicated red tide with high Paralytic Shellfish Poisoning (PSP) level. Red tide is a phenomenon caused by an explosive growth and accumulation of certain microscopic algae, predominantly dinoflagellates, in coastal waters. The Bureau of Fisheries and Aquatic Resources (BFAR) stated that red tide which occurred in Davao is caused by dinoflagellates (Gomez, 2019).

In summary, for Davao to Surabaya, the presence of toxic algae which is blooming in donor port leads to high risk situation.

4.3.20. Shekou (China) to Surabaya (Indonesia)

Shekou port is located on South China Sea. The salinity of this port is 32.19 PSU. Because Shekou port and Surabaya port have same condition (above 30 PSU), so species specific BWM RA was conducted. Based on scientific literature and internet sources, this port contains *Vibrio spp* (human pathogen) which is above the standard. A journal article says that Shekou port contains 216 cfu / 100 ml of *Vibrio spp*. This port also indicator microbes such as *E. Coli* and *Enterococcus*. The concentration for *E. Coli* is 2 cfu / 100 ml (meets the regulation) and *Enterococcus* is 187 cfu / 100 ml (Siang, et al., 2018).

In summary, for Shekou to Surabaya, the presence of human pathogens and *Enterococcus* with concentrations above the D-2 standard results in a high risk situation.

4.3.21. Gove (Australia) to Surabaya (Indonesia)

Port of Gove is located on Gulf of Carpentaria. The salinity of this port is 28.76 PSU. Although Gove port and Surabaya port have a different salinity but the salinity of Gove port is not below 0.5 PSU, so species specific

BWM RA was conducted. Based on scientific literature and internet sources, there are human pathogens, such as, *Vibrio vulnificus, Vibrio parahaemolyticus, Vibrio damsela, Vibrio alginolyticus,* and *Vibrio cholerae* (Ralph & Currie, 2006).

In summary, for Gove to Surabaya, the presence of human pathogens results in a high risk situation.

4.3.22. Taipei (Taiwan) to Surabaya (Indonesia)

Both ports, Taipei and Surabaya, have similar salinity conditions (above 30 PSU). Because the salinity of both ports is comparable so that the species-specific RA was carried out. Internet search reveals there is no report about human pathogen and indicator microbes. However, a journal says that this area has target species which is *Rapana Venosa*. (David & Gollasch, 2010)

In summary, for Taiwan to Surabaya, the presence of target species in donor port leads to very high situation.

4.3.23. Shimizu (Japan) to Surabaya (Indonesia)

The port of Shimizu's salinity is same as with Surabaya port that is above 30 PSU. So, we have to do the next step which is species-specific risk assessment. The port of Shimizu is located on Suruga Bay so to answer the question "Is any BW donor port outside the receptor region?" The answer is "Yes". Internet search reveals there is no report about human pathogen, indicator microbes, and target species. However, a journal says that in 2010, a vessel, *M.V Royal Diamond*, berthed in Shimizu port which contained toxic algae, such as, *Pseudonitzschia spp., Ceratium fusus, and Ceratium fusca*. Although, *M.V Royal Diamond* contained toxic algae in ballast water but it was not blooming in Shimizu port (Baek, et al., 2011).

In summary, for Shimizu to Surabaya, the presence of toxic algae which is not blooming in donor port leads to intermediate risk situation.

4.3.24. Laem Chabang (Thailand) to Surabaya (Indonesia)

Laem Chabang port is located on Gulf of Thailand. The salinity of this port is 28.77 PSU. Although Laem Chabang port and Surabaya port have a different salinity but the salinity of donor port is not below 0.5 PSU, so species specific BWM RA carried out. Based on scientific literature and internet sources, this port contains *Vibrio spp* (human pathogen) which is above the standard. A journal article says that Laem Chabang port contains more than 300 cfu / 100 ml of *Vibrio spp*. This port also indicator microbes such as *E. Coli* and *Enterococcus* but it meets the D-2 standard. The concentration for *E. Coli* is 1 cfu / 100 ml and *Enterococcus* is 5 cfu / 100 ml (Siang, et al., 2018).

In summary, for Laem Chabang to Surabaya, the presence of human pathogen which is above the D-2 standard results in a high risk situation.

4.3.25. Dili (Timor Leste) to Surabaya (Indonesia)

The port of Dili's salinity is same as with Surabaya port that is above 30 PSU. So, we have to do the next step which is species-specific risk assessment. The port of Dili is located on Banda Sea so to answer the question "Is any BW donor port outside the receptor region?" The answer is "Yes". Internet search reveals there is no report about human pathogen, indicator microbes, and target species. However, a journal says that this area has toxic algae which produces PSP (Paralytic Shellfish Poisoning) toxins, such as *Alexandrium andersonii, Alexandrium catenella, Alexandrium cohorticula, Alexandrium fraterculus, Alexandrium fundyense, Alexandrium minutum, Alexandrium tamarensis, Aphanazomenon flos-aquae, Gymnodinium catenatum, Pyrodinium bahamense, Spondylus butler,* and *Zosimous acnus* (Campas, et al., 2007). Even though Dili port contained toxic algae but there is no report that states it was blooming.

In summary, for Dili to Surabaya, the presence of toxic algae which is not blooming in donor port leads to intermediate risk situation.

4.3.26. Ulsan (Korea) to Surabaya (Indonesia)

Port of Ulsan is located on Sea of Japan and it has similar salinity conditions (above 30 PSU) with Surabaya port. Because the salinity of both ports is comparable so that the species-specific RA was carried out. Internet search reveals there is no report about human pathogen, indicator microbes. However, a journal says that Sea of Japan contains *Rapana Venosa* (David & Gollasch, 2010). *Rapana Venosa* is a target species because it has caused significant changes to the ecosystem. It has a high ecological fitness as evidenced by its high fertility, fast growth rate and tolerance to low salinity, high and low temperatures, water pollution and oxygen deficiency (ISSG, 2006). An internet search also reveals that Ulsan port contains toxic algae which is *Cochlodinium polykrikoides* (Lee, et al., 2013). Even though Ulsan port contained toxic algae but there is no report that states it was blooming. ‘

In summary, for Ulsan to Surabaya, the presence of target species in donor port leads to high risk situation.

4.3.27. Taichung (Taiwan) to Surabaya (Indonesia)

Taichung port is located on South China Sea. The salinity of this port is 36.97 PSU. Because Taichung port and Surabaya port have same condition (above 30 PSU), so species specific BWM RA was conducted. Based on scientific literature and internet sources, this port contains *Vibrio spp* (human pathogen) which is above the standard. A journal article says that Taichung port contains 120 cfu / 100 ml of *Vibrio spp.* However, the concentration of indicator microbes such as *E. Coli* and *Enterococcous* 0 cfu / 100 ml. It means *E. Coli* and *Enterococcus* in this port are below the standard (Siang, et al., 2018).

In summary, for Taichung to Surabaya, the presence of human pathogen which is above the D-2 standard results in a high risk situation.

4.3.28. Gwangyang (Korea) to Surabaya (Indonesia)

The port of Gwangyang's salinity is same as with Surabaya port that is above 30 PSU. So, we have to do the next step which is species-specific risk assessment. The port of Gwangyang is located on East China Sea so to answer the question "Is any BW donor port outside the receptor region?" The answer is "Yes". Internet search reveals there is no report about human pathogen, indicator microbes, and target species. However, a journal says that this area has toxic algae which is *Skeletonema spp* and *Pseudonitzchia spp* (Baek, et al., 2014). Even though Gwangyang port contained toxic algae but there is no report that states it was blooming.

In summary, for Gwangyang to Surabaya, the presence of toxic algae which is not blooming in donor port leads to intermediate risk situation.

4.3.29. Nagoya (Japan) to Surabaya (Indonesia)

Both ports, Nagoya and Surabaya, have similar salinity conditions (above 30 PSU). Because the salinity of both ports is comparable so that the species-specific RA was carried out. Internet search reveals there is no report about human pathogen, indicator microbes, and target species. However, a journal says that in 2010, a vessel, *C.S. Crane*, berthed in Shimizu port which contained toxic algae such as *Pseudonitzschia sp*. Although, *C.S. Crane* contained toxic algae in ballast water but it was not blooming in Nagoya port (Baek, et al., 2011).

In summary, for Nagoya to Surabaya, the presence of toxic algae which is not blooming in donor port leads to intermediate risk situation.

4.3.30. Yangon (Myanmar) to Surabaya (Indonesia)

Yangon port is located on Northern Bay of Bengal. The salinity of this port is 29.41 PSU. Although Yangon port and Surabaya port have a different salinity but the salinity of donor port is not below 0.5 PSU, so species specific BWM RA carried out. Based on scientific literature and internet sources, this port contains *Vibrio spp* (human pathogen) which is above the standard. A journal article says that Yangon port contains 5 cfu / 100 ml of *Vibrio spp*. This port also indicator microbes such as *E. Coli* and *Enterococcus*. The concentration for *E. Coli* is 16 cfu / 100 ml (meets the regulation) and *Enterococcus* is 100 cfu / 100 ml (Siang, et al., 2018).

In summary, for Yangon to Surabaya, the presence of human pathogens and *Enterococcus* with concentrations above the D-2 standard results in a high risk situation.

4.3.31. Bangkok (Thailand) to Surabaya (Indonesia)

Port of Bangkok is located on Gulf of Thailand. The salinity of this port is 5.37 PSU. Although Bangkok port and Surabaya port have a different salinity but the salinity of Bangkok port is not below 0.5 PSU, so species specific BWM RA was conducted. Port of Laem Chabang and Port of Bangkok are in same ecoregion. Moreover, the distance between Laem Chabang port and Bangkok port is about 60nm, so we can assume that the water content in Laem Chabang port is the same as in Bangkok port. Based on scientific literature and internet sources, this donor port contains *Vibrio spp* (human pathogen) which is above the standard. A journal article also says that Bangkok port contains more than 300 cfu / 100 ml of *Vibrio spp*. This port also indicator microbes such as *E. Coli* and *Enterococcus* but it meets the D-2 standard. The concentration for *E. Coli* is 1 cfu / 100 ml and *Enterococcus* is 5 cfu / 100 ml (Siang, et al., 2018).

In summary, for Bangkok to Surabaya, the presence of human pathogens leads to high risk situation.

4.3.32. Lianyungang (China) to Surabaya (Indonesia)

Both ports, Lianyungang and Surabaya, have similar salinity conditions (above 30 PSU). Because the salinity of both ports is comparable so that the species-specific RA was carried out. Based on scientific literature and internet sources, this port contains *Vibrio spp* (human pathogen) which is above the standard. A journal article says that Lianyungang port contains 1.54 x 10^4 cfu / 100 ml of *Vibrio spp*. This port also indicator microbes such as *E. Coli* and *Enterococcus* and both of them not meet the regulation. The concentration for *E. Coli* is 593 cfu / 100 ml and *Enterococcus* is 494 cfu / 100 ml (IMO, 2013). Because Lianyungang port is located on Yellow Sea, so it also contains *Rapana Venosa* as target species (David & Gollasch, 2010).

In summary, for Lianyungang to Surabaya, the presence of human pathogen, indicator microbes, and target species leads to high risk situation.

4.3.33. Taiping (China) to Surabaya (Indonesia)

Taiping port is located on South China Sea. The salinity of this port is 8.46 PSU. Although Taiping port and Surabaya port have a different salinity but the salinity of donor port is not below 0.5 PSU, so species specific BWM RA carried out. Based on scientific literature and internet sources, this port contains *Vibrio spp* (human pathogen) which is above the standard. A journal article says that Taiping port contains 120 cfu / 100 ml of *Vibrio spp*. However, the concentration of indicator microbes such as *E. Coli* and *Enterococcous* 0 cfu / 100 ml. It means *E. Coli* and *Enterococcus* in this port are below the standard (Siang, et al., 2018).

In summary, for Taiping to Surabaya, the presence of human pathogen which is above the D-2 standard results in a high risk situation.

4.3.34. Tianjin (China) to Surabaya (Indonesia)

Tianjin port is located on Yellow Sea. The salinity of this port is 28.88 PSU (below 30 PSU). Although Tianjin port and Surabaya port have a different salinity but the salinity of donor port is not below 0.5 PSU, so species specific BWM RA carried out. Based on internet sources, this port does not contain human pathogen and indicator microbes. However, an internet search says that Yellow Sea contains Rapana Venosa (David & Gollasch, 2010). *Rapana Venosa* is a target species or unwanted species that can cause significant changes to the ecosystem.

In summary, for Tianjin to Surabaya, the presence of target specie leads to high risk situation.

4.3.35. Tokyo (Japan) to Surabaya (Indonesia)

Tokyo port's salinity is same as Surabaya which is above 30 PSU. So, we have to do the next step which is species-specific risk assessment. The port of Tokyo is located on Tokyo Bay so to answer the question "Is any BW donor port outside the receptor region?" The answer is "Yes”. Internet search reveals there is no report about human pathogen, indicator microbes, and target species. However, an internet search says that Tokyo Bay contains toxic algae, such as, *Pseudonitzschia spp.*, *Alexandrium tamarense*, and *Heterocapsa circularisquama* (Nagai, et al., 2017). Even though Tokyo port contained toxic algae but there is no report that states it was blooming.

In summary, for Tokyo to Surabaya, the presence of toxic algae which is not blooming in donor port leads to intermediate risk situation.

4.3.36. Ho Chi Minh (Vietnam) to Surabaya (Indonesia)

Ho Chi Minh port is located on Southern Vietnam. The salinity of this port is 1.15 PSU. Although Ho Chi Minh port and Surabaya port have a different salinity but the salinity of donor port is not below 0.5 PSU, so species specific BWM RA carried out. Based on scientific literature and internet sources, this port contains *Vibrio spp* (human pathogen) which is above the standard. A journal article says that Ho Chi Minh port contains above 300 cfu / 100 ml of *Vibrio spp.* However, the concentration of indicator microbes such as *E. Coli* and *Enterococcous* 0 cfu / 100 ml. It means *E. Coli* and *Enterococcus* in this port are below the standard (Siang, et al., 2018).

In summary, for Ho Chi Minh to Surabaya, the presence of human pathogen which is above the D-2 standard results in a high risk situation.

4.3.37. Yukuhashi (Japan) to Surabaya (Indonesia)

Because the salinity at this port could not be found, the answer to the question "Is data needed for RA reliable?" Is "No" so that the risk assessment of this port is intermediate risk.

4.4. The Risk of Ballast Water in Each Terminal

4.4.1. Terminal Jamrud

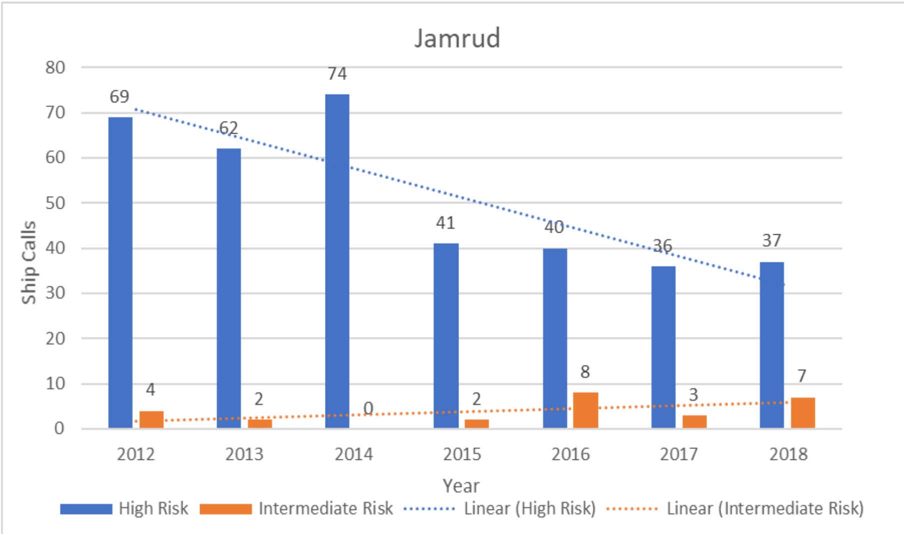


Figure 4. 5. Risk of Ballast Water in Terminal Jamurd 2012-2018

Based on **Figure 4.5** the graph shows the information about risk of ballast water in Terminal Jamrud from 2012 to 2018. The highest number of high risk level happens in 2014 with 74 ship calls. In 2016, Terminal Jamrud had the highest number of intermediate risk with 8 ship calls. To summarize, the number of ship calls with high risk decreased from 2012 until 2018 and the number of ship calls with intermediate risk increased from 2012 until 2018.

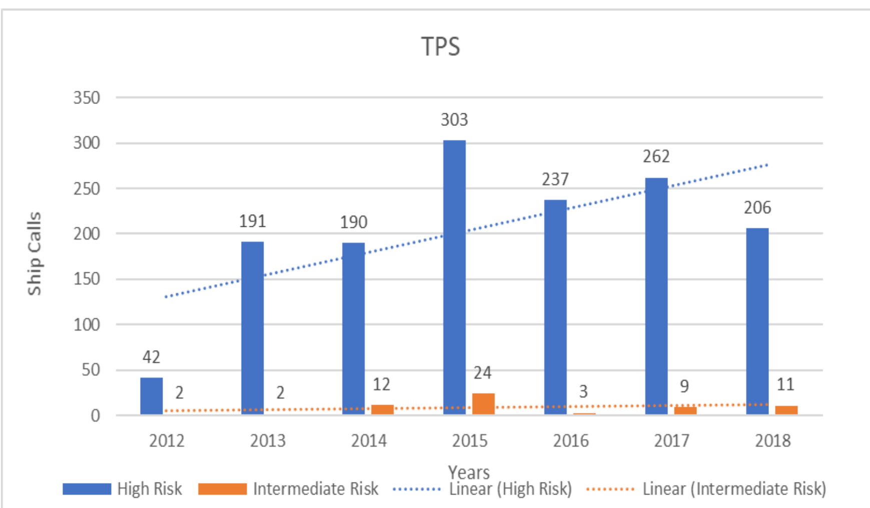


Figure 4. 6. Risk of ballast water in Terminal Peti Kemas Surabaya 2012-2018

4.4.2. Terminal Petik Kemas Surabaya

Based on **Figure 4.6** the graph shows the information about risk of ballast water in Terminal Peti Kemas Surabaya from 2012 to 2018. The highest number of high risk level happens in 2015 with 303 ship calls. In 2015, Terminal Peti Kemas Surabaya also had the highest number of intermediate risk with 24 ship calls. To summarize, the number of ship calls with high risk increased from 2012 until 2018 and the number of ship calls with intermediate risk increased from 2012 until 2018.

4.4.3. Terminal Teluk Lamong

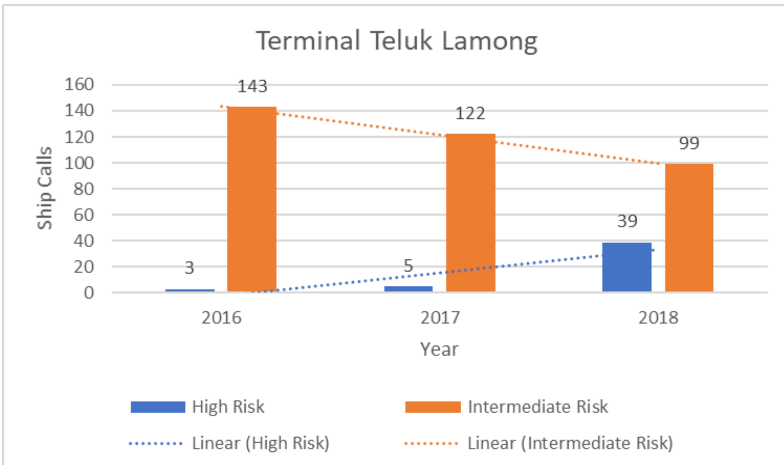


Figure 4. 7. Risk of ballast water in Terminal Teluk Lamong in 2016-2018

Based on **Figure 4.7** the graph shows the information about risk of ballast water in Terminal Teluk Lamong from 2016 to 2018. The highest number of high risk level happens in 2018 with 39 ship calls. In 2016, Terminal Teluk Lamong had the highest number of intermediate risk with 143 ship calls. To summarize, the number of ship calls with high risk increased from 2016 until 2018 and the number of ship calls with intermediate risk decreased from 2016 until 2018.

4.5. Ballast Water Management Options and Consequences

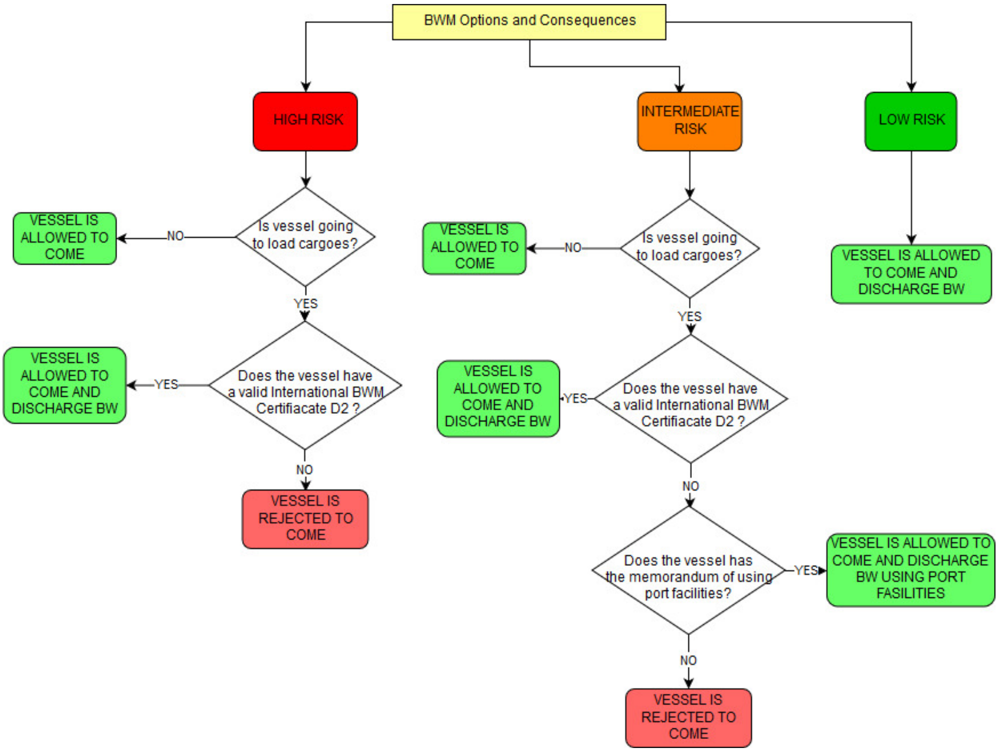


Figure 4. 8. Decision BWM Options and Consequences (enhaced)
Source: (David & Gollasch, 2018)

After we get results for every port, the next step is to decide options and consequences for every action. If the result of ballast water risk assessment is low risk, then the vessel is allowed to come and discharge ballast water without further action.

The high risk ballast water is accepted to come to the port if:

- Vessel is not going to discharge the ballast or load cargoes.
- Vessel that has International Certificate D-2 Standard is going to discharge ballast water or load cargoes.

The intermediated risk ballast water is accepted to come to the port if:

- Vessel is not going to discharge the ballast or load cargoes;
- Vessel that has International Certificate D-2 Standard;
- Vessel that has memorandum to use port facilities.

In case vessels with high risk or intermediate risk was not able to fulfill the above conditions, they will be ignored. The ballast water management options and consequences are summarized in **Figure 4.8.**

4.6. Developing Software Application

4.6.1. Developing Database

The first step to build a software application is establishing the database. Database is a gathering place for information that we have obtained in the previous step. The process of inputting information can we see in **Figure 4.9** and **Figure 4.10**.

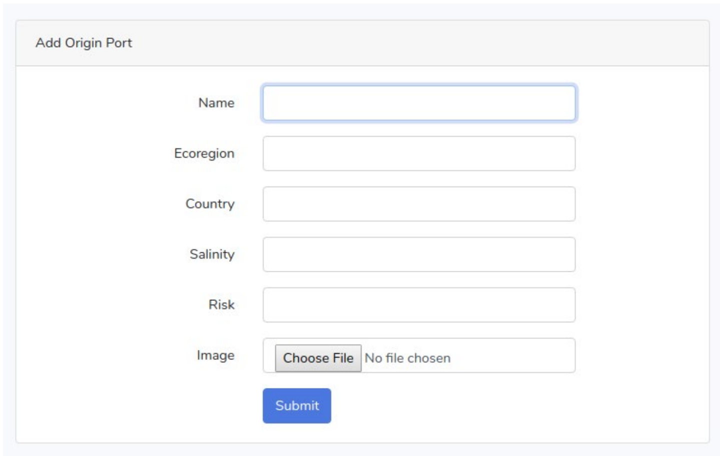
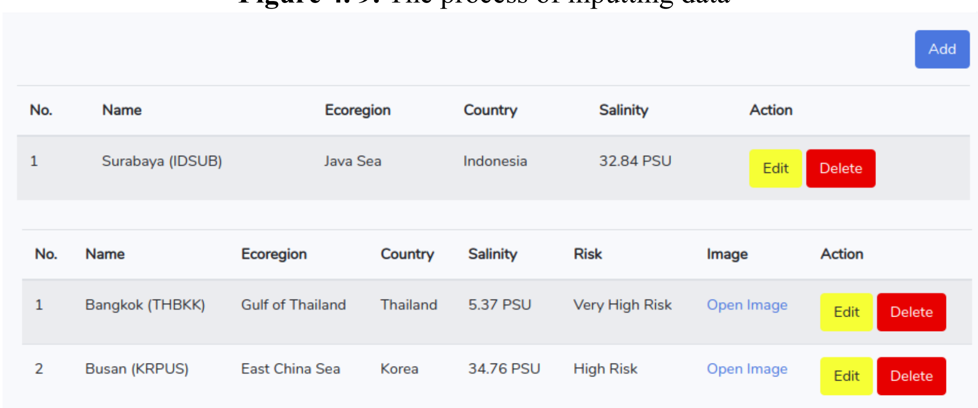


Figure 4. 9. The process of inputting data



Add

No.	Name	Ecoregion	Country	Salinity	Action
1	Surabaya (IDSUB)	Java Sea	Indonesia	32.84 PSU	Edit Delete

No.	Name	Ecoregion	Country	Salinity	Risk	Image	Action
1	Bangkok (THBKK)	Gulf of Thailand	Thailand	5.37 PSU	Very High Risk	Open Image	Edit Delete
2	Busan (KRPUS)	East China Sea	Korea	34.76 PSU	High Risk	Open Image	Edit Delete

Figure 4. 10. The interface of database

4.6.2. Developing Website

After establishing the database, the next step is establishing the website. Website are places where we can access information that we have entered into the database. The interface of the website, can we see in **Figure 4.11**. The website also can be accessed on www.bwmtoolidsub.com

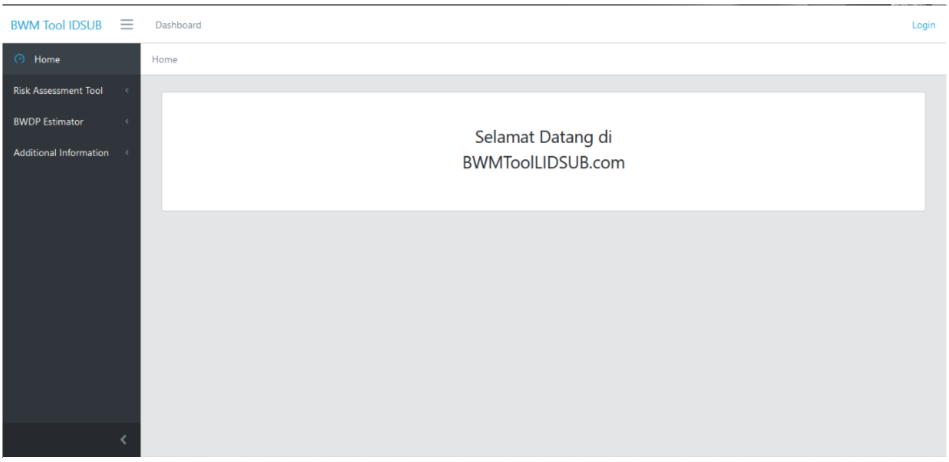


Figure 4. 11. The interface of the website

4.6.3. Converting to Android Application

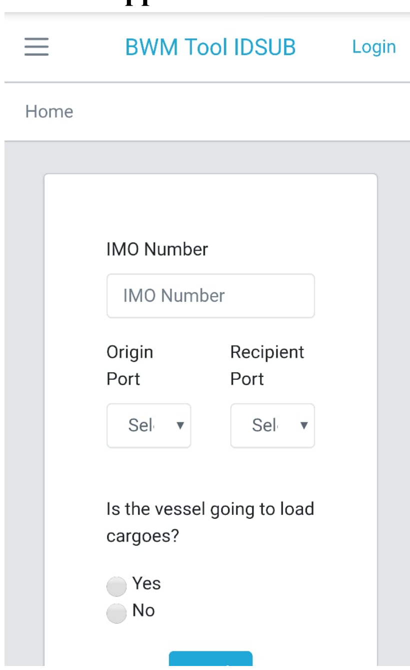


Figure 4. 12. The interface of android application

The last step is converting website to android application. The purpose of this step is to make this software application more portable and efficient, so everyone can access it from everywhere with their smartphone. The interface of this Android Application, can we see in **Figure 4.12**. It also can be accessed by downloading from google play store with "BWM Tool IDSUB" as a keyword.

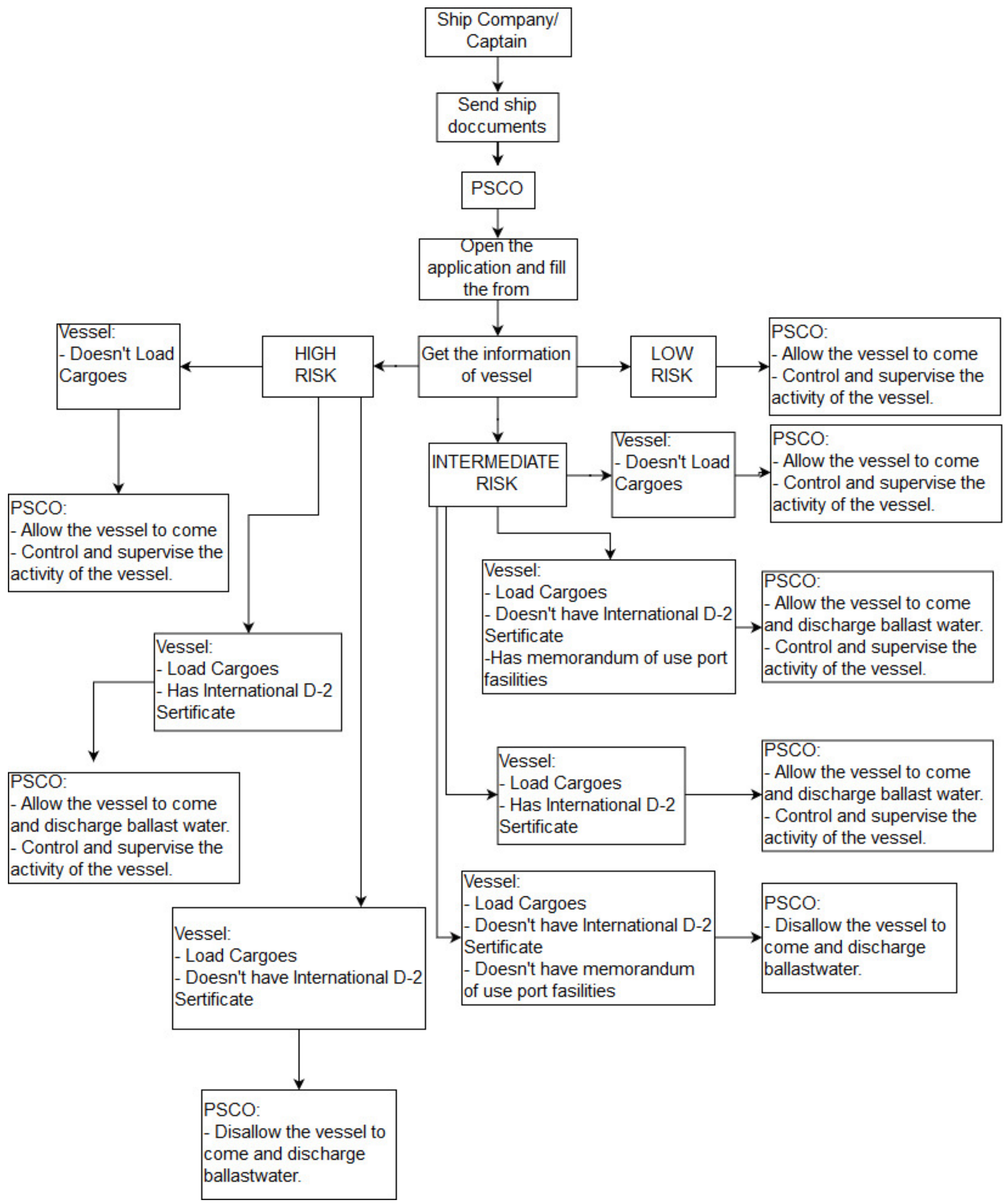


Figure 4. 13. Working Principle of Software Application

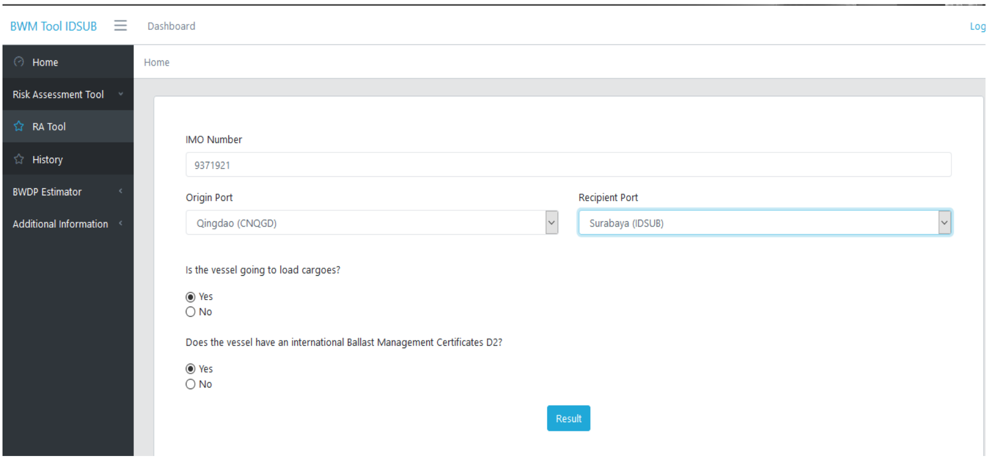


Figure 4. 15. The form that must be filled

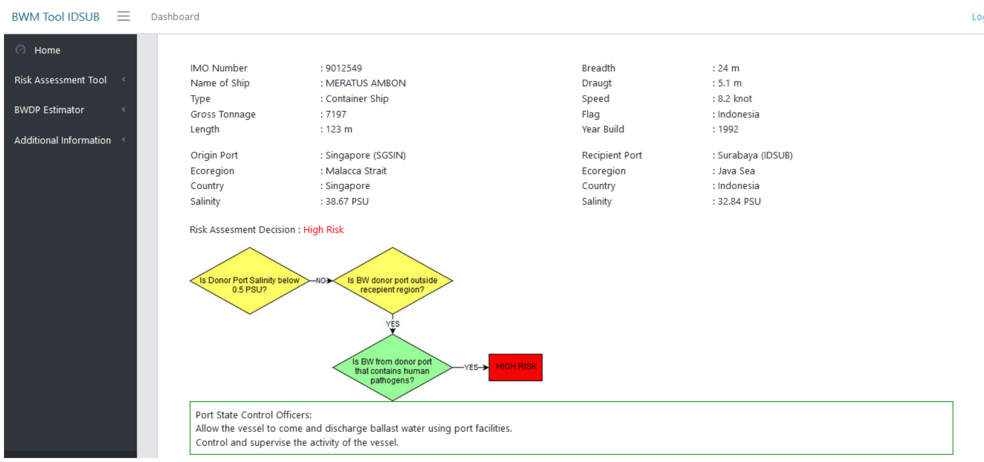


Figure 4. 14. Information and Conclusion about BWM

4.7. Standard Operational Procedure (SOP) for PSOC in Realization BWMC

Figure 4.13 explains the standard operational procedure (SOP) for PSCO. First, shipping company or captain send the document of vessel, e.g., ship particular, arrival report (LK3), and ship certificate to PSCO maximum 24 hours before vessel arrives. Second, PSCO should fill the information form, e.g., IMO number, origin port, recipient port, arrival date, and some questions about ballast water management through the website or android application. It can be seen in **Figure 4.14**. Third, PSCO will get the information of the vessel e.g., ship practical, ecoregion, salinity, country, risk level, and conclusion. PSCO will get the information about ship particular if they fill the IMO number form that has been saved in the database of the application. However, if PSCO fill the IMO number that has not been saved in database, the information of the ship particular will be not available. The illustrative of that information can be seen in **Figure 4.15**. Last, PSCO acts based on the result of it. The information that is inputted by PSCO through the website will be saved in history and converted into informative chart. The interface of the history can be seen Figure **4.16** history and converted into informative chart. The interface of the history can be seen in **figure 4.16.**

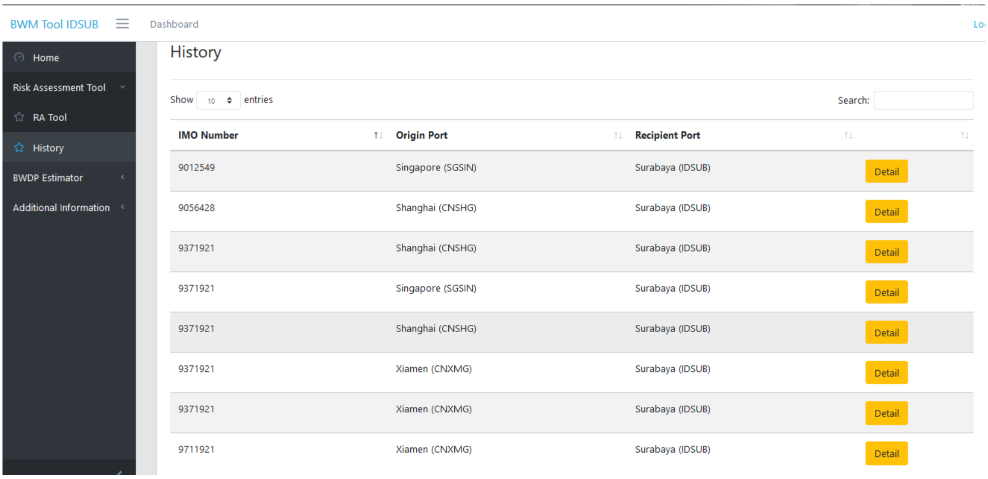


Figure 4. 16. The Interface of History

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CHAPTER V
CONCLUSIONS AND SUGGESTIONS

5.1. Conclusions

The conclusions of this thesis are:

1. Surabaya port, as recipient port in this study, is located on Java Sea and has 32.84 PSU (Practical Salinity Unit). Vessels which come from ports outside the ecoregion of java sea (donor port) mostly have the same salinity as the recipient port (Above 30 PSU). From the data, Port of Davao has the highest salinity with 38.73 PSU and Port of Ho Chi Minh has the lowest salinity with 1.15 PSU. There are 23 donor ports which contains human pathogens. The most commonly reported human pathogens in journals are *Vibrio spp*. There are 11 donor ports which contains toxic algae or harmful algae. The most commonly reported toxic algae in journals are *Pseudonitzschia spp.*
2. Almost all of donor ports have high risk level. Only 8 of 37 donor ports that have intermediate risk level, e.g., Dili port, Shanghai Port, Busan Port, Shimizu port, Gwangyang port, Nagoya port, Tokyo Port, and Yukuhashi port. There is no donor port with low risk level because the salinity of donor ports is not below 0.5 PSU. In other word, donor ports and recipient port have a same condition.
3. The main option for ballast water management is to keep ballast water on board. It means vessels do not discharge their ballast water, so recipient port will not be harmed or polluted by harmful aquatic organism and pathogen. If vessels truly need to discharge their ballast water, then they should be conducted with. the D-2 Standard.
4. There some steps that must be done to develop software application, e.g., developing database, developing website, and converting website to android application. First, user should fill the information form, e.g., IMO number, origin port, recipient port, arrival date, and some questions about ballast water management through the website or android application. Third, user will get the information of the vessel e.g., ship practical, ecoregion, salinity, country, risk level, and conclusion. The information that is inputted by user through the website will be saved in history and converted into informative chart. The software application can be accessed on www.bwmtoolidsub.com or download the application for android operating system user in “Additional Information” menu of the website.

5.2. Suggestions

Suggestions of this thesis are:

1. Ballast water sampling method should be carried out on ships that berth at the recipient port. Data obtained from ballast water sampling will be very supportive for the validation process because the data is the most updated data.
2. Harmful Aquatic Organism and Pathogen (HAOP) database will be very helpful and informative if it is available on software application.
3. It would be great if International Port such as Batam port, Jakarta port, Surabaya port and Semarang port develop ballast water management software application as well as OSPAR and BALMAS did.

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APPENDIX I

NO	Port Code	Source Port	Ecoregion	Country	Ships Call	Is data needed for RA reliable?
1	SGSIN	SINAGPORE	Malacca Strait	SINGAPORE	617	Yes
2	TWKHH	KAOHSIUNG	Southern China	TAIWAN	534	Yes
3	MYTPP	TANJUNG PELEPAS	Malacca Strait	MALAYSIA	298	Yes
4	TLDIL	DILI	Banda Sea	TIMOR LESTE	268	Yes
5	CNSHG	SHANGHAI	East China Sea	CHINA	110	Yes
6	MYPKG	KLANG	Malacca Strait	MALAYSIA	110	Yes
7	KRPUS	BUSAN	East China Sea	KOREA	89	Yes
8	HKHKG	HONG KONG	Southern China	HONG KONG	69	Yes
9	MYWSP	WESTPORT	Malacca Strait	MALAYSIA	57	Yes
10	CNSHK	SHEKOU	Southern China	CHINA	26	Yes
11	CNNGB	NINGBO	East China Sea	CHINA	19	Yes
12	PHDVO	DAVAO	Eastern Philippines	PHILIPPINES	15	Yes
13	TWTPE	TAIPEI	East China Sea	TAIWAN	14	Yes
14	CNXMG	XIAMEN	Southern China	CHINA	9	Yes
15	JPSMZ	SHIMIZU	Suruga Bay	JAPAN	8	Yes
16	MYPGU	PASIR GUDANG	Malacca Strait	MALAYSIA	8	Yes
17	KRUSN	ULSAN	Sea of Japan	KOREA	5	Yes
18	THLCH	LAEM CHABANG	Gulf of Thailand	THAILAND	4	Yes
19	TWTXG	TAICHUNG	Southern China	TAIWAN	4	Yes
20	KRKAN	GWANGYANG	East China Sea	KOREA	4	Yes
21	MMRGN	YANGON	Nothern Bay of Bengal	MYANMAR	3	Yes
22	CNYAT	YANTIAN	Southern China	CHINA	3	Yes
23	JPNGO	NAGOYA	Ise Bay	JAPAN	2	Yes
24	THBKK	BANGKOK	Gulf of Thailand	THAILAND	2	Yes
25	CNLYG	LIANYUNGANG	Yellow Sea	CHINA	2	Yes
26	CNTXG	TIANJIN	Yellow Sea	CHINA	1	Yes
27	AUGOV	GOVE	Gulf of Carpentaria	AUSTRALIA	1	Yes
28	CNTAP	TAIPING	Southern China	CHINA	1	Yes
29	VNSGN	HO CHI MINH	Southern Vietnam	VIETNAM	1	Yes
30	PHMNN	MANILA NORTH	Eastern Philippines	PHILIPPINES	1	Yes
31	CNQGD	QINGDAO	Yellow Sea	CHINA	1	Yes
32	MYPEN	PENANG	Malacca Strait	MALAYSIA	1	Yes
33	JPTYO	TOKYO	Tokyo Bay	JAPAN	1	Yes
34	PHSFS	SUBIC BAY	Eastern Philippines	PHILIPPINES	1	Yes
35	CNDLC	DALIAN	Yellow Sea	CHINA	1	Yes
36	CNNSA	NANSHA	Southern China	CHINA	1	Yes
37	JPYKH	YUKUHASHI	Central Kuroshio Current	JAPAN	1	No

NO	Source Port	Salinity (PSU)	Is Donor Port Salinity below 0.5 PSU?	Is any BW donor port outside recepient region?	Is any BW from donor port that contains human pathogens?
1	SINAGPORE	38.67	No	Yes	Yes
2	KAOHSIUNG	35.25	No	Yes	Yes
3	TANJUNG PELEPAS	30.28	No	Yes	Yes
4	DILI	34.24	No	Yes	No
5	SHANGHAI	1.5	No	Yes	No
6	KLANG	32.19	No	Yes	Yes
7	BUSAN	34.76	No	Yes	No
8	HONG KONG	25.71	No	Yes	Yes
9	WESTPORT	32.19	No	Yes	Yes
10	SHEKOU	29.23	No	Yes	Yes
11	NINGBO	22.03	No	Yes	Yes
12	DAVAO	38.73	No	Yes	No
13	TAIPEI	34.21	No	Yes	No
14	XIAMEN	36.51	No	Yes	Yes
15	SHIMIZU	35.26	No	Yes	No
16	PASIR GUDANG	31.85	No	Yes	Yes
17	ULSAN	34.35	No	Yes	No
18	LAEM CHABANG	28.77	No	Yes	Yes
19	TAICHUNG	36.97	No	Yes	Yes
20	GWANGYANG	33.4	No	Yes	No
21	YANGON	29.41	No	Yes	Yes
22	YANTIAN	36.68	No	Yes	Yes
23	NAGOYA	29.28	No	Yes	No
24	BANGKOK	5.37	No	Yes	Yes
25	LIANYUNGANG	33.75	No	Yes	Yes
26	TIANJIN	28.88	No	Yes	No
27	GOVE	28.76	No	Yes	Yes
28	TAIPING	8.46	No	Yes	Yes
29	HO CHI MINH	1.15	No	Yes	Yes
30	MANILA NORTH	38.51	No	Yes	No
31	QINGDAO	36.8	No	Yes	Yes
32	PENANG	36.46	No	Yes	Yes
33	TOKYO	34.98	No	Yes	No
34	SUBIC BAY	34.59	No	Yes	No
35	DALIAN	32.92	No	Yes	No
36	NANSHA	30.62	No	Yes	Yes
37	YUKUHASHI			Yes	

NO	Source Port	Is any BW from donor port that contains indicator microbes?	Is concentration of E.coli 250 cfu per 100 ml or above?	Is concentration of Enterococci 100 cfu per 100 ml or above?	Is any BW from donor port that contains target species?
1	SINAGPORE	Yes	No	Yes	-
2	KAOHSIUNG	Yes	No	Yes	-
3	TANJUNG PELEPAS	Yes	No	No	-
4	DILI	No	-	-	No
5	SHANGHAI	No	-	-	No
6	KLANG	Yes	No	Yes	-
7	BUSAN	No	-	-	No
8	HONG KONG	Yes	No	No	-
9	WESTPORT	Yes	No	Yes	-
10	SHEKOU	Yes	No	Yes	-
11	NINGBO	No	-	-	-
12	DAVAO	No	-	-	No
13	TAIPEI	No	-	-	Yes
14	XIAMEN	Yes	No	No	-
15	SHIMIZU	No	-	-	No
16	PASIR GUDANG	Yes	Yes	No	-
17	ULSAN	No	-	-	Yes
18	LAEM CHABANG	Yes	No	No	-
19	TAICHUNG	No	-	-	-
20	GWANGYANG	No	-	-	No
21	YANGON	Yes	No	Yes	-
22	YANTIAN	Yes	No	No	-
23	NAGOYA	No	-	-	No
24	BANGKOK	Yes	No	No	-
25	LIANYUNGANG	Yes	Yes	Yes	Yes
26	TIANJIN	No	-	-	Yes
27	GOVE	No	-	-	-
28	TAIPING	No	-	-	-
29	HO CHI MINH	No	-	-	-
30	MANILA NORTH	No	-	-	No
31	QINGDAO	Yes	No	No	Yes
32	PENANG	Yes	No	Yes	-
33	TOKYO	No	-	-	No
34	SUBIC BAY	No	-	-	No
35	DALIAN	Yes	No	No	Yes
36	NANSHA	Yes	No	Yes	-
37	YUKUHASHI				

NO	Source Port	Were toxic algae in bloom state in donor port?	Are HAO in donor port also present in recipient port?	Status
1	SINAGPORE	-	-	High Risk
2	KAOHSIUNG	-	-	High Risk
3	TANJUNG PELEPAS	-	-	High Risk
4	DILI	No	-	Intermediate Risk
5	SHANGHAI	No	-	Intermediate Risk
6	KLANG	-	-	High Risk
7	BUSAN	No	-	Intermediate Risk
8	HONG KONG	-	-	High Risk
9	WESTPORT	-	-	High Risk
10	SHEKOU	-	-	High Risk
11	NINGBO	-	-	High Risk
12	DAVAO	Yes	-	High Risk
13	TAIPEI	-	-	High Risk
14	XIAMEN	-	-	High Risk
15	SHIMIZU	No	-	Intermediate Risk
16	PASIR GUDANG	-	-	High Risk
17	ULSAN	No	-	High Risk
18	LAEM CHABANG	-	-	High Risk
19	TAICHUNG	-	-	High Risk
20	GWANGYANG	No	-	Intermediate Risk
21	YANGON	-	-	High Risk
22	YANTIAN	-	-	High Risk
23	NAGOYA	No	-	Intermediate Risk
24	BANGKOK	-	-	High Risk
25	LIANYUNGANG	-	-	High Risk
26	TIANJIN	-	-	High Risk
27	GOVE	-	-	High Risk
28	TAIPING	-	-	High Risk
29	HO CHI MINH	-	-	High Risk
30	MANILA NORTH	Yes	-	High Risk
31	QINGDAO	-	-	High Risk
32	PENANG	-	-	High Risk
33	TOKYO	No	-	Intermediate Risk
34	SUBIC BAY	Yes	-	High Risk
35	DALIAN	-	-	High Risk
36	NANSHA	-	-	High Risk
37	YUKUHASHI			Intermediate Risk

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APPENDIX II

No	IMO Number	Name of Ship	Type	Gross Tonnage	Length (m)	Flag	Year Built
1	9470791	AC SESODA	Bulk Carier	17018	169	Panama	2008
2	9494462	ALL MARINE 09	General Cargo	1998	84	Vietnam	2007
3	9576820	BALTIC PROSPERITY	Oil Tanker	11383	142	Liberia	2012
4	9119660	BLPL TRUST	Container Ship	15778	166	Panama	1996
5	9153331	ENTERPRISE	General Cargo	4743	96	Togo	1996
6	9369100	LIZSTAR SUCCESS	General Cargo	9932	127	Panama	2007
7	9341354	QUEEN HELENA	Chemical Tanker	10549	150	Panama	2006
8	9586978	TIEN QUANG 68	Bulk Carier	2999	92	Hong Kong	2008
9	9270828	ACACIA MAKOTO	Container Ship	21932	197	Singapore	2004
10	9360611	ACX CRYSTAL	Container Ship	29060	223	Panama	2008
11	9360623	ACX PEARL	Container Ship	29060	223	Liberia	2008
12	9138161	AEGEAN EXPRES	Container Ship	15095	168	Panama	1997
13	8619118	AIM	Chemical Tanker	2518	90	Thailand	1987
14	9341122	ALDI WAVE	Container Ship	28616	222	Cyprus	2008
15	9354844	ALEXANDRA	Bulk Carier	43205	229	Greece	2006
16	9274721	ALFA TRANS SATU	General Cargo	1594	60	Indonesia	2002
17	9525950	ALS VESTA	Container Ship	26374	209	Singapore	2014
18	9217553	ALTONIA	Container Ship	16803	184	Portugal	2000
19	9505510	AMOENITAS	Container Ship	11473	134	Antigua Barbuda	2010
20	9593086	AMP DIAMOND	General Cargo	6980	112	Hong Kong	2010
21	8414958	AN ZE JIANG	General Cargo	11115	149	China	1987
22	9434709	ANGEL NO 1	Chemical Tanker	8550	127	Panama	2008
23	8701002	ANNA K	General Cargo	1167	68	Denmark	1987
24	9101508	ANYA	Container Ship	14936	167	Palau	1995
25	9360697	APOLLON D	Container Ship	26358	209	Liberia	2008
26	9382061	ARGENT DAISY	Oil Tanker	20267	175	Panama	2009
27	9385805	ARIKUN	General Cargo	6000	112	Panama	2007
28	9315757	ARIONAS	Oil Tanker	23270	184	Marshall Island	2006
29	9509475	ARKLOW MOOR	General Cargo	9758	136	Ireland	2011
30	9320037	AS COLUMBIA	Container Ship	27971	221	Portugal	2006
31	9308390	AS CONSTANTINA	Container Ship	37883	221	portugal	2005
32	9308390	AS CONSTANTINA	Container Ship	28400	221	Portugal	2005
33	9294549	AS PAULINE	Container Ship	26611	210	Liberia	2006
34	9449821	AS ROMINA	Container Ship	17000	180	Portugal	2009
35	9449845	AS ROSALIA	Container Ship	17068	180	Portugal	2009
36	9010022	ASIA BRIDGE	General Cargo	5551	98	Togo	1991
37	9101572	ASIA GLORY 6	General Cargo	6155	100	Indonesia	1994
38	9186481	ATLANTIC ACE	Bulk Carier	18061	170	Tuvalu	1999
39	9536844	ATLANTIC GLORY	Bulk Carier	21290	180	Marshall Island	2011
40	9306225	AVA D	Container Ship	15545	168	Liberia	2007
41	9036416	AYAN	Container Ship	4937	115	Indonesia	1990
42	9426324	BAHAMIAN EXPRESS	Container Ship	20600	180	Gibraltar	2010
43	9477610	BALTHASAR SCHULTE	Container Ship	40542	261	Liberia	2012
44	9563706	BBC AMBER	General Cargo	12838	153	Antigua Barbuda	2011
45	9501655	BBC BELEM	General Cargo	6310	128	Antigua Barbuda	2012

No	IMO Number	Name of Ship	Type	Gross Tonnage	Length (m)	Flag	Year Built
46	9571375	BBC NILE	General Cargo	12974	143	Antigua Barbuda	2011
47	9508469	BBC RUSHMORE	General Cargo	8255	126	Antigua Barbuda	2012
48	9508483	BBC XINGANG	General Cargo	8255	126	Antigua Barbuda	2008
49	9488047	BILLESBORG	General Cargo	9611	139	Panama	2011
50	7919767	BINTANG JASA 25	General Cargo	2636	94	Indonesia	1982
51	7919779	BINTANG JASA 27	General Cargo	2636	94	Indonesia	1981
52	7928249	BINTANG JASA 29	General Cargo	4152	101	Eritrea	1981
53	9509267	BM UNION	General Cargo	6494	118	Panama	2009
54	9109938	BO SPRING	General Cargo	7656	114	South Korea	1994
55	9305013	BOMAR AURORA	Container Ship	27915	215	Marshall Island	2005
56	9330501	BOMAR FULGENT	Container Ship	36000	238	Liberia	2007
57	9064334	BONAVIA	Container Ship	23691	188	Liberia	1995
58	9457153	BORKUM	General Cargo	4591	108	Antigua Barbuda	2012
59	9504217	BOW NANGANG	Oil Tanker	6583	120	Singapore	2013
60	8416322	BOW VICTOR	Chemical Tanker	19685	183	Norway	1986
61	9733832	BOX EXPRESS	Container Ship	17907	172	Liberia	2016
62	9033505	BRAVE LEADER	Bulk Carier	13706	157	Lebanon	1992
63	9157442	BRIGHT STATE	General Cargo	9991	138	Hong Kong	1997
64	9315472	BRILLIANT PESCADORES	General Cargo	12004	116	Panama	2005
65	9771664	CALIFORNIA TRADER	Container Ship	31370	186	Malta	2006
66	9498224	CAPE	Bulk Carier	19865	186	Liberia	2010
67	9347724	CAPE FLINT	Container Ship	15900	170	Marshall Island	2006
68	9348857	CAPE MAHON	Container Ship	28007	221	Cyprus	2007
69	9308405	CAPE MORETON	Container Ship	28150	221	Marshall Island	2005
70	9436173	CAPE NEMO	Container Ship	18257	175	Marshall Island	2010
71	9294159	CAPT THANASIS	Container Ship	25000	221	Marshall Island	2005
72	9200184	CARAKA JAYA NIAGA III 36	Container Ship	3401	98	Indonesia	1998
73	9253038	CARPATHIA	Container Ship	27779	222	Liberia	2003
74	9428815	CARPE DIEM II	Oil Tanker	17800	170	Marshall Island	2010
75	9340439	CHEM WOLVERINE	Oil Tanker	11561	145	Marshall Island	2006
76	9610755	CHILOE ISLAND	Bulk Carier	32377	190	Hong Kong	2013
77	9241190	CIMBRIA	Container Ship	27779	220	Liberia	2002
78	9152090	CLARITY 08	Container Ship	4635	95	Indonesia	1997
79	9294173	CMACGM POINTECARAIBE	Container Ship	28592	222	Marshall Island	2005
80	9364344	CONTSHIP BEE	Container Ship	9940	148	Liberia	2006
81	9379026	CONTSHIP UNO	Container Ship	9966	148	Liberia	2007
82	9625437	COREBRIGHT OL	General Cargo	9963	127	Panama	2012
83	9075424	COUGAR	Oil Tanker	7358	119	Singapore	1995
84	9440813	CPO NORFOLK	Container Ship	41358	262	Liberia	2009
85	9557953	CSC CHANG HAI	General Cargo	6550	118	Hong Kong	2009
86	9556911	CSC RONG HAI	General Cargo	6550	118	Hong Kong	2009
87	9602863	CSC XINHAI	General Cargo	10817	122	Hong Kong	2012
88	9400813	CSCL KINGSTON	Container Ship	27104	199	Panama	2008
89	9238789	CUCKOO HUNTER	Container Ship	39941	260	Liberia	2003
90	9649110	DENSA SEAL	Bulk Carier	22709	187	Malta	2013

No	IMO Number	Name of Ship	Type	Gross Tonnage	Length (m)	Flag	Year Built
91	8921676	DIAMOND SKY	General Cargo	5144	110	Palau	1990
92	9390719	DL DIAMOND	Chemical Tanker	2298	113	South Korea	2008
93	9394777	DMC VENUS	Bulk Carier	4095	103	Vietnam	2006
94	9119191	DONG AN	General Cargo	5552	99	Vietnam	1994
95	9548093	DONG AN QUEEN	General Cargo	3000	97	Vietnam	2008
96	9391543	DONG BA	General Cargo	4095	103	Vietnam	2006
97	9279939	DORIS RUBY	Oil Tanker	6861	123	Hong Kong	2003
98	9268552	DRAGON LUCKY	Oil Tanker	5378	112	Panama	2002
99	9629471	DYNAMIC OCEAN 02	Bulk Carier	4358	108	Vietnam	2011
100	9109952	EAST PROSPERITY	General Cargo	5471	98	Panama	1995
101	9115406	EAST SEAWAY	General Cargo	6155	101	Panama	1995
102	9290880	EASTERN GLORY	Bulk Carier	88548	289	Panama	2004
103	9575888	EASY DEVELOPMENT	General Cargo	8374	118	Hong Kong	2010
104	9439852	EDZARD SCHULTE	Oil Tanker	11246	145	United Kingdom	2011
105	9123348	ELEGANT	Chemical Tanker	5979	125	India	1996
106	9450167	ELEGANT SW	Bulk Carier	22852	178	Panama	2011
107	9301366	ERAWAN 12	Oil Tanker	4432	105	Indonesia	2003
108	9546227	EUROSUN	Bulk Carier	23432	180	Liberia	2012
109	9130511	EVER ALLY	Container Ship	14807	165	Palau	1996
110	9786968	EVER BASIS	Container Ship	33266	211	Taiwan	2018
111	9787003	EVER BEAMY	Container Ship	33266	212	Taiwan	2018
112	9784128	EVER BEFIT	Container Ship	32145	211	Taiwan	2018
113	9786932	EVER BLISS	Container Ship	32659	212	Panama	2017
114	9786994	EVER BONUS	Container Ship	32659	212	Panama	2018
115	9249219	EVER PEARL	Container Ship	17887	182	Singapore	2002
116	9249233	EVER PRIDE	Container Ship	17887	182	United Kingdom	2003
117	9263643	EVER RICH NO 18	Oil Tanker	56285	239	Panama	2003
118	9439838	EVERHARD SCHULTE	Oil Tanker	11267	145	Singapore	2010
119	9153654	FAIRLANE	Heavy Lift Cargo	7971	109	Netherlands	1999
120	9200419	FEDERAL ASAHI	Bulk Carier	20659	200	Marshall Island	2000
121	9581057	FENG AN	Bulk Carier	13622	159	Panama	2008
122	9168233	FESCO TRADER	Container Ship	12471	147	Cyprus	1997
123	9140396	FORTUNE ISLAND	General Cargo	4736	97	Indonesia	1995
124	9010010	FORTUNE OCEAN	General Cargo	5551	98	Panama	1990
125	9347982	FRISIA ALLER	Container Ship	10000	148	Cyprus	2007
126	9337250	FRISIA GOTEBORG	Container Ship	27800	222	Liberia	2006
127	9359715	G ACE	Container Ship	27104	200	Hong Kong	2007
128	9122394	GALLI	Container Ship	29383	195	St Kitts Nevis	1996
129	9151400	GANOSAYA	Bulk Carier	11246	149	Cook Islands	1997
130	9379856	GENIUS STAR VII	General Cargo	9589	119	Panama	2006
131	9418377	GH LESTE	Container Ship	35000	229	Marshall Island	2010
132	9436472	GH ZONDA	Container Ship	36007	231	Marshall Island	2008
133	9557343	GIANG HAI 09	General Cargo	2840	92	Vietnam	2012
134	9700081	GIANTS CAUSEWAY	Bulk Carier	35872	199	United Kingdom	2015
135	9543940	GINTO	General Cargo	9731	120	Philippines	2011

No	IMO Number	Name of Ship	Type	Gross Tonnage	Length (m)	Flag	Year Built
136	9562829	GLOBAL IRIS	Oil Tanker	7321	128	Panama	2009
137	9576909	GLOBAL MARS	Oil Tanker	7326	128	Panama	2010
138	8317071	GLOBAL SEA	Tanker	3795	104	Equatorial Guinea	1984
139	9490284	GLOBE6	General Cargo	2551	110	Vietnam	2008
140	9675042	GLORY CHALLENGER	General Cargo	8696	117	Singapore	2013
141	9287845	GLORY WISDOM	General Cargo	5394	97	Singapore	2003
142	9453729	GOLDEN AMBROSIA	Oil Tanker	8302	131	Singapore	2008
143	9141209	GOLDEN AUTUMN	General Cargo	10000	127	Panama	1996
144	9305544	GOLDEN TAKA	Chemical Tanker	11594	144	Panama	2003
145	9407081	GOLDEN YOSA	Chemical Tanker	11645	144	Panama	2008
146	9169859	GRACE PIONEER	General Cargo	6714	100	Panama	1998
147	9575993	GREAT TRUST DRAGON 1	General Cargo	2551	92	Vietnam	2008
148	9572147	GREAT TRUST DRAGON 2	Bulk Carier	2551	92	Vietnam	2008
149	9441752	GREEN PACIFIC	Container Ship	12545	147	Vietnam	2008
150	9408360	GS AVENUE	Tanker	6149	118	Liberia	2009
151	9436434	GUENTHER SCHULTE	Container Ship	35991	231	Hong Kong	2008
152	9464235	HAI WANG ZHI XING	General Cargo	7460	122	China	2008
153	9585455	HAM RONG 08	General Cargo	1309	76	Vietnam	2008
154	9151527	HAMMONIA THRACIUM	Container Ship	29383	195	Liberia	1997
155	9009102	HAN SPLENDOR	General Cargo	5515	98	South Korea	1990
156	9074846	HANGLIMA	General Cargo	3884	95	Indonesia	1993
157	9152612	HANSA CALYPSO	Container Ship	16915	168	Liberia	1998
158	9152595	HANSA CASTELLA	Container Ship	16915	169	Liberia	1998
159	9535101	HANSA FRESENBURG	Container Ship	18296	175	Liberia	2013
160	9236212	HANSA NORDBURG	Container Ship	18334	175	Liberia	2001
161	9414199	HARTWIG SCAN	General Cargo	4990	119	Antigua Barbuda	2007
162	9776509	HIBARINO	General Cargo	9658	128	Panama	2016
163	9158575	HIGHWAY	Container Ship	21611	182	Panama	1998
164	9101560	HIJAU SAMUDRA	Container Ship	15184	166	Indonesia	1995
165	9233856	HOLSATIA	Container Ship	39941	260	United Kingdom	2003
166	9224336	HONGKONG BRIDGE	Container Ship	39941	260	Marshall Island	2001
167	9290206	HONOR PESCADORES	General Cargo	8451	117	Panama	2003
168	9263320	HOPE ISLAND	Container Ship	35975	231	Marshall Island	2007
169	9323027	HS CHOPIN	Container Ship	38320	247	Liberia	2007
170	9134608	HS MASTER	Container Ship	23897	188	Liberia	1997
171	9550981	HTK VENUS	General Cargo	2551	91	Vietnam	2009
172	9020091	HUI FENG 88	Container Ship	5519	99	Togo	1991
173	9637155	HYUNDAI PLATINUM	Container Ship	52400	255	Liberia	2013
174	9194490	IBN AL ABBAR	Container Ship	16705	183	Panama	1999
175	9352341	INDUSTRIAL HOBART	General Cargo	4990	118	Sri Lanka	2009
176	9315862	IRENES RELIANCE	Container Ship	28592	222	Marshall Island	2005
177	9455909	ISOBEL	Container Ship	18334	176	Marshall Island	2010
178	9474395	ITALIAN EXPRESS	Container Ship	9900	149	Gibraltar	2011
179	9117131	ITHA BHUM	Container Ship	15533	171	Thailand	1996
180	9620138	IVS RAFFLES	Bulk Carier	20928	180	Singapore	2013

No	IMO Number	Name of Ship	Type	Gross Tonnage	Length (m)	Flag	Year Built
181	9181821	JACARANDA	General Cargo	6178	101	Panama	1998
182	9136541	JIA FENG	Bulk Carier	15073	160	Togo	1996
183	9287209	JIAN DA	Bulk Carier	29377	188	Panama	2004
184	9609847	JIN DA	Bulk Carier	22402	180	Panama	2011
185	9255074	JOO DO	Bulk Carier	19883	172	South Korea	2003
186	9215191	JOSEPHINE MAERSK	Container Ship	30166	216	Denmark	2002
187	9537109	KAITANK	Chemical Tanker	3953	103	Cyprus	2008
188	9454357	KALLIROE	Container Ship	18334	175	Liberia	2011
189	9166833	KAMO	General Cargo	8145	120	Panama	1998
190	9130157	KAPITAN MASLOV	Container Ship	16575	184	Cyprus	1998
191	9510929	KEN KON	Bulk Carier	22852	178	Panama	2013
192	9074030	KIBI	General Cargo	8145	120	Panama	1994
193	8601393	KM ISA CLARITY	General Cargo	4469	95	Indonesia	1985
194	8840195	KM SURYA PAPUA	General Cargo	1305	69	Indonesia	1990
195	9375513	KMTC CHENNAI	Container Ship	40487	257	South Korea	2008
196	9375501	KMTC NHAVA SHEVA	Container Ship	40800	261	South Korea	2008
197	9282273	KMTC PORT KELANG	Container Ship	20815	187	Panama	2004
198	9274202	KMTC SHANGHAI	Container Ship	20815	187	South Korea	2004
199	9408449	KOTA DAHLIA	Container Ship	6500	115	Singapore	2007
200	9151307	KOTA HADIAH	Container Ship	13272	160	Singapore	1997
201	9151319	KOTA HARMUNI	Container Ship	13272	159	Singapore	1997
202	9205665	KOTA JATI	Container Ship	18502	194	Hong Kong	2000
203	9205677	KOTA JAYA	Container Ship	18502	193	Hong Kong	2000
204	9226839	KOTA JUTA	Container Ship	18502	193	Marshall Island	2001
205	9296298	KOTA RANCAK	Container Ship	9678	146	Singapore	2005
206	9071208	KOTA WISATA	Container Ship	17125	176	Singapore	1994
207	9009188	KYAUK PHYU STAR	Container Ship	18487	193	China	1992
208	9384887	KYOTO TOWER	Container Ship	17229	172	United Kingdom	2007
209	9160401	LADY OF LUCK	Container Ship	26131	195	Panama	1998
210	9444807	LAI BAO	Chemical Tanker	4340	108	Nauru	2006
211	9377559	LAILA	Container Ship	28048	216	Portugal	2008
212	9506136	LANGEOOG	General Cargo	4591	108	Antigua Barbuda	2013
213	9496939	LANNA NAREE	Bulk Carier	22641	181	Thailand	2012
214	7808786	LAPIN	Oil Tanker	1848	85	Thailand	1978
215	9363390	LEO PERDANA	Container Ship	27104	199	Panama	2007
216	9391139	LEVANTE	Chemical Tanker	12560	149	Liberia	2008
217	9546019	LIANG HUI	General Cargo	5667	123	Hong Kong	2008
218	9483334	LINDAUNIS	Container Ship	10585	151	Liberia	2012
219	9087661	LIVIA	Oil Tanker	5404	105	Panama	1993
220	9228564	LOBIVIA	Container Ship	23652	188	Liberia	2001
221	9376933	LONGHUNG 5	Oil Tanker	8455	127	Panama	2007
222	9311763	LORRAINE	Container Ship	27786	221	Liberia	2006
223	9451472	LOS ANDES BRIDGE	Container Ship	27094	200	Panama	2009
224	9119062	LUCKY STAR 11	General Cargo	5543	98	Palau	1995
225	9608506	M T SOUTHERN GROWTH	General Cargo	4264	105	Vietnam	2015

No	IMO Number	Name of Ship	Type	Gross Tonnage	Length (m)	Flag	Year Built
226	8801333	MADISON	General Cargo	12129	156	Indonesia	1989
227	9175793	MAERSK ABERDEEN	Container Ship	14063	155	Hong Kong	1999
228	9410301	MAERSK WOLGAST	Container Ship	18123	175	Liberia	2010
229	9122447	MAGNAVIA	Container Ship	23828	188	Liberia	1996
230	9323027	MAJD	Container Ship	38320	247	Qatar	2007
231	9168477	MAPLE	Oil Tanker	12044	147	Singapore	1998
232	9478523	MARIANNA	Bulk Carier	31532	190	Liberia	2010
233	9464534	MARIKA	Bulk Carier	17018	170	Liberia	2008
234	9445007	MARINE BIA	Container Ship	17280	171	Panama	2008
235	9053232	MARINOS	Container Ship	16236	164	Liberia	1993
236	9401336	MATSUMAE	General Cargo	9998	125	Panama	2007
237	9477672	MATSUSHIRO	General Cargo	9998	125	Panama	2009
238	9357547	MCC KYOTO	Container Ship	18123	175	Liberia	2008
239	9393498	MCP LARNACA	Container Ship	5315	117	Cyprus	2007
240	9134969	MEGA STAR	General Cargo	6369	100	South Korea	1995
241	9012549	MERATUS AMBON	Container Ship	7197	123	Indonesia	1992
242	9147124	MERATUS DILI	Container Ship	5296	118	Indonesia	1997
243	9064695	MERATUS KENDARI 1	Container Ship	5737	120	Indonesia	1993
244	9371921	MERATUS PALEMBANG	Container Ship	5272	117	Indonesia	2007
245	9371995	MERATUS PEKANBARU	Container Ship	5272	117	Indonesia	2008
246	9056428	MERATUS ULTIMA 1	Container Ship	4896	108	Indonesia	1992
247	9423683	MID FORTUNE	Chemical Tanker	11919	147	Cyman Islands	2009
248	9542154	MID NATURE	Chemical Tanker	11987	146	Cyman Islands	2011
249	9601869	MIIKE	General Cargo	9815	128	Panama	2011
250	9354208	MIKAWA	General Cargo	9762	128	Panama	2006
251	9515606	MILLENNIUM BRIGHT	Container Ship	17211	172	Panama	2008
252	9527958	MIMITSU	General Cargo	23855	185	Panama	2012
253	9390903	MIURA	Chemical Tanker	12560	149	Liberia	2008
254	9228772	MIYUNHE	Container Ship	16738	183	Panama	2001
255	9472567	MOL SPARKLE	Container Ship	27104	199	Panama	2009
256	9314961	MONACO	Container Ship	28927	222	Liberia	2006
257	9442172	MP THE MCGINEST	Container Ship	43100	262	Liberia	2010
258	9314997	MS EAGLE	Container Ship	28927	222	Marshall Island	2007
259	9303819	MS HAWK	Container Ship	28592	222	Marshall Island	2007
260	9235581	MSC ADITI	Container Ship	27779	222	Liberia	2002
261	9148025	MSC ANAHITA	Container Ship	29022	196	Liberia	1997
262	9263344	MSC ASTRID	Container Ship	35954	230	Panama	2004
263	9124512	MSC CARLA 3	Container Ship	31730	192	Liberia	1997
264	7925493	MSC GIANNA	Container Ship	27758	210	Panama	1981
265	8408818	MSC GIORGIA	Container Ship	22667	187	Panama	1985
266	8201686	MSC HINA	Container Ship	21586	203	Panama	1984
267	9124366	MSC IMMA	Container Ship	30280	202	Panama	1996
268	8413887	MSC LUCIA	Container Ship	21887	189	Panama	1985
269	9155107	MSC MARIA PIA	Container Ship	29115	196	Panama	1997
270	9062996	MSC MILA 3	Container Ship	23540	188	Liberia	1995

No	IMO Number	Name of Ship	Type	Gross Tonnage	Length (m)	Flag	Year Built
271	9007831	MSC REUNION	Container Ship	23953	181	Liberia	1992
272	9141895	MT LUCKY 6	Oil Tanker	6275	117	Panama	1996
273	9390525	MT MUTIARA PERAK	Oil Tanker	7057	121	Malaysia	2007
274	9542104	MT PENYUAN	Chemical Tanker	4996	118	Malaysia	2009
275	9164500	MT WELBECK	Chemical Tanker	8594	133	Marshall Island	1999
276	8619015	MULTI SARANA	General Cargo	1829	80	Indonesia	1988
277	8114209	MV AYA 3	General Cargo	2587	87	Indonesia	1981
278	7801312	MV BUDDY RAKHMADI	General Cargo	7236	124	Indonesia	1978
279	9656967	MV INTAN DAYA 7	General Cargo	4437	99	Indonesia	2011
280	9101106	MV MAYMO STAR	Container Ship	15095	169	Malaysia	1995
281	8420153	MV MENANG JAYA	General Cargo	2867	90	Indonesia	1984
282	9760603	MV MOUNT GOUGH	Container Ship	18870	170	Hong Kong	2015
283	9360257	MV PROTOSTAR N	Container Ship	28007	221	Cyprus	2007
284	9197026	MV RED ROCK	Container Ship	4391	100	Indonesia	2000
285	9172507	MV SINAR KUDUS	General Cargo	7717	112	Indonesia	1999
286	9314404	MV THANH THUY	General Cargo	4095	103	Vietnam	2004
287	9589243	MV XUYEN A 18	Bulk Carier	1599	79	Vietnam	2008
288	9114660	NARIMOTO MARU	General Cargo	7416	96	Belize	1995
289	9315836	NASIA	Container Ship	28927	215	Marshall Island	2005
290	9308027	NAVIOS SPRING	Container Ship	36000	239	Marshall Island	2007
291	8717881	NEW GLORY	General Cargo	2354	91	Indonesia	1988
292	9046136	NEW LIGHT	General Cargo	3810	97	Indonesia	1993
293	9071167	NEW SAILING 2	General Cargo	5542	98	Panama	1993
294	9192454	NICOLAI MAERSK	Container Ship	27733	198	Denmark	2000
295	1016831	NOGOGINI	Oil Tanker	6270	127	Singapore	1996
296	9519200	NORD TOKYO	Bulk Carier	17023	169	Singapore	2009
297	9744673	NORDCLAIRE	Container Ship	18826	170	Malta	2016
298	9626235	NORDLION	Container Ship	18826	170	Cyprus	2014
299	9329643	NORTHERN DEFENDER	Container Ship	35975	231	Liberia	2007
300	9391787	NORTHERN DEMOCRAT	Container Ship	36007	230	Liberia	2009
301	9405033	NORTHERN DIAMOND	Container Ship	35697	231	Liberia	2009
302	9304966	NORTHERN VIVACITY	Container Ship	27437	221	Portugal	2005
303	9304978	NORTHERN VOLITION	Container Ship	28150	221	Portugal	2005
304	9387449	NYK JOANNA	Container Ship	27003	210	Singapore	2009
305	9643192	OCEAN BRIGHT	Bulk Carier	31756	190	Panama	2013
306	9315824	ODYSSEUS	Container Ship	28592	222	Liberia	2006
307	9134660	OEL LANKA	Container Ship	16801	183	Panama	1997
308	9765574	OLYMPIA	Container Ship	17674	172	Marshall Island	2017
309	9244386	ONSAN CHEMI	Chemical Tanker	6823	123	South Korea	2001
310	9440045	OOCL NORFOLK	Container Ship	40168	260	Hong Kong	2008
311	9194804	ORIENT PINE	Oil Tanker	4854	111	South Korea	1999
312	9485837	OSLO BULK 10	General Cargo	5629	108	Singapore	2011
313	9485801	OSLO BULK 7	General Cargo	5629	108	Singapore	2008
314	9485813	OSLO BULK 8	General Cargo	5629	108	Singapore	2011
315	9272656	PAC ADARA	General Cargo	20471	178	Singapore	2003

No	IMO Number	Name of Ship	Type	Gross Tonnage	Length (m)	Flag	Year Built
316	9004061	PACIFIC EAGLE	General Cargo	5518	98	Panama	1990
317	8112914	PACIFIC LADY	Chemical Tanker	18829	172	Panama	1988
318	9162112	PARAMITA	Oil Tanker	6270	117	Marshall Island	1998
319	9088201	PEGASUS 01	General Cargo	5552	98	St Vincent Grenadines	1994
320	8417962	PHOPHYONG	Bulk Carier	12308	152	North Korea	1985
321	9517135	PHUONG DONG 10	General Cargo	4219	102	Vietnam	2011
322	7645328	PIONER B	General Cargo	5590	130	Cambodia	1977
323	9429194	POLLUX	Container Ship	9000	158	Antigua Barbuda	2009
324	9108221	POLO	Container Ship	15095	168	Comoros	1995
325	9363429	PORT ADELAIDE	Container Ship	27104	199	Panama	2007
326	9349887	POSEN	Container Ship	27962	222	Germany	2007
327	9159842	PRINCESS OF ELLA	Container Ship	16705	184	Palau	1997
328	9313474	PTI AMAZON	Oil Tanker	30068	183	Malta	2007
329	9444950	PUTNAM	Container Ship	17515	172	Liberia	2008
330	9438250	QAASWA	Chemical Tanker	6190	118	United Arab Emirates	118
331	9440071	QUANG MINH	General Cargo	2153	79	Vietnam	2005
332	9550993	QUANG MINH 6	General Cargo	2551	90	Vietnam	2008
333	9088512	QUEEN OF LUCK	Container Ship	16316	163	Panama	1995
334	9620293	QUEEN YAN	General Cargo	6980	112	Hong Kong	2010
335	9236561	RACHA BHUM	Container Ship	32060	211	Singapore	2008
336	9051583	RED RESOURCE	General Cargo	4489	100	Indonesia	1995
337	8912900	RED ROVER	General Cargo	4559	105	Indonesia	1997
338	9334844	RHL ASTRUM	Container Ship	18300	177	Liberia	2006
339	9123843	RICH OCEAN 7	General Cargo	7673	114	Togo	1995
340	9237254	RICH OCEAN 9	General Cargo	7433	110	Panama	2000
341	9381366	ROYAL AQUA	Chemical Tanker	8539	128	Marshall Island	2008
342	9178070	RUI HAI 1	General Cargo	4724	97	Palau	1998
343	9175731	SAEHAN GLORIA	Chemical Tanker	5999	118	South Korea	1997
344	9175767	SAEHAN HARMONIA	Chemical Tanker	5997	125	Panama	1998
345	9240330	SATTHA BHUM	Container Ship	32060	211	Singapore	2009
346	9425045	SC CHONGQING	Chemical Tanker	6028	115	Hong Kong	2010
347	8601446	SC SUNNY	Bulk Carier	12301	155	Panama	1986
348	9255828	SCOT BAYERN	Chemical Tanker	5145	117	Malta	2003
349	9499955	SEA CORAL	General Cargo	9932	128	Panama	2008
350	9202481	SEA OF LUCK	Container Ship	17167	169	Panama	2000
351	9115004	SEA ROSE	Bulk Carier	25997	217	Indonesia	1995
352	9181807	SEA STAR 9	General Cargo	6178	100	Panama	1998
353	9364887	SEIYO HONOR	General Cargo	7454	111	Panama	2006
354	9353931	SELATAN DAMAI	Container Ship	6500	116	Indonesia	2007
355	9312432	SENDANG MAS	Container Ship	27900	215	Indonesia	2005
356	9015773	SHANGHAI M	RoRo Ship	8889	124	Panama	1992
357	8521799	SHANNON PROSPER	General Cargo	2147	79	Kiribati	1985
358	9244374	SICHEM DEFIANCE	Chemical Tanker	9900	136	Marshall Island	2001
359	9397007	SICHEM HONG KONG	Oil Tanker	8537	128	Bermuda	2007
360	9376921	SICHEM MELBOURNE	Chemical Tanker	8455	127	Marshall Island	2007

No	IMO Number	Name of Ship	Type	Gross Tonnage	Length (m)	Flag	Year Built
361	9404900	SICHEM MONTREAL	Oil Tanker	8537	128	Bermuda	2008
362	9322073	SICHEM RIO	Chemical Tanker	8562	121	Malta	2006
363	9607655	SILVER PEACE	General Cargo	9129	120	Hong Kong	2011
364	9412799	SINAR BITUNG	General Cargo	13596	162	Panama	2007
365	9435234	SINAR SABANG	General Cargo	18409	175	Singapore	2008
366	9435222	SINAR SUMBA	General Cargo	18321	174	Singapore	2008
367	8718328	SINDE	General Cargo	492	55	Dominica	1988
368	9343089	SINE A	Container Ship	27910	222	Malta	2008
369	9478262	SINGAPORE PIONEER	Oil Tanker	6968	112	Singapore	2009
370	9705940	SK LINE 1	Chemical Tanker	3200	91	Singapore	2013
371	9776133	SLOMAN HESTIA	Oil Tanker	11316	145	Antigua Barbuda	2017
372	9219240	SM JAKARTA	Container Ship	16850	168	Liberia	2000
373	8303616	SMOOTH SEA 3	Oil Tanker	4301	91	Thailand	1983
374	9135573	SONG SHAN	General Cargo	7633	113	Hong Kong	1996
375	9392561	SONGA HAYDN	Container Ship	35981	231	Liberia	2010
376	9470973	SONGA NUERNBERG	Container Ship	21842	189	Liberia	2010
377	9148647	SOUL OF LUCK	Container Ship	16915	162	Panama	1997
378	9114529	SPRING HUMMER	General Cargo	8011	110	Belize	1995
379	9619567	SPRING NELSON	General Cargo	7100	112	Hong Kong	2011
380	9505895	SPRING SALIM	General Cargo	7460	122	Panama	2008
381	9505950	SPRING VALEN	General Cargo	7460	122	Hong Kong	2008
382	9532288	ST BLUE	Container Ship	27061	199	Liberia	2011
383	9536985	ST EVER	Container Ship	27061	199	Liberia	2011
384	9532276	ST ISLAND	Container Ship	27061	199	Liberia	2010
385	9219252	ST MARY	Container Ship	16850	168	Cyprus	2001
386	9320049	STADT DRESDEN	Container Ship	28400	221	Portugal	2006
387	9320037	STADT ROSTOCK	Container Ship	27971	221	Antigua Barbuda	2006
388	9608568	STAR 62	General Cargo	1599	78	Vietnam	2013
389	8419829	STAR ASIA	Chemical Tanker	4084	108	Thailand	1985
390	9148659	STAR OF LUCK	Container Ship	16915	168	Panama	1997
391	9815458	STAR RIVER	Oil Tanker	26150	180	Marshall Island	2016
392	9661235	STENAWECO MARJORIE K	Oil Tanker	29940	183	Marshall Island	2013
393	9713014	SUNRISE HOPE	Chemical Tanker	7247	122	Marshall Island	2014
394	9315484	SUPERIOR PESCADORES	General Cargo	8479	117	Panama	2005
395	9130121	SZCZECIN TRADER	Container Ship	16803	184	Liberia	1998
396	9194505	TAICHUNG	Container Ship	16705	183	Panama	1999
397	9122875	TAN BINH 39	General Cargo	15438	159	Panama	1996
398	9118408	TANTO PRATAMA	Container Ship	17613	183	Indonesia	1995
399	8812899	TERRITORY TRADER	General Cargo	2826	20	Indonesia	1990
400	9282376	THAI LOTUS	General Cargo	9004	119	Panama	2003
401	9300142	THANA BHUM	Container Ship	21516	197	Singapore	2005
402	9169598	THANLWIN STAR	Oil Tanker	3824	113	China	1996
403	9124055	THERESA DUA	Oil Tanker	9597	149	Tuvalu	1996
404	9162277	THORSKY	Container Ship	21583	184	Liberia	1999
405	9135638	THORSWAVE	Container Ship	29022	195	Liberia	1996

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406	9627071	TIEN THANH 26	Oil Tanker	1700	79	Vietnam	2011
407	9621728	TONG CHENG 702	Bulk Carier	5092	113	China	2011
408	9232541	TOYO PEARL	General Cargo	8739	111	Panama	2000
409	8214748	TRESNAWATI	General Cargo	2864	84	Indonesia	1983
410	9733351	TRF KIRKENES	Oil Tanker	12138	146	Marshall Island	2016
411	9359727	TS TAICHUNG	Container Ship	27104	200	Taiwan	2007
412	9251236	TTC VINH AN	General Cargo	4089	108	Vietnam	2001
413	9570632	TUNGOR	General Cargo	7138	130	Liberia	2011
414	9660152	ULTRA CAPE TOWN	General Cargo	13110	132	Hong Kong	2013
415	9143348	UNI AHEAD	Container Ship	14796	165	Panama	1997
416	9143336	UNI AMPLE	Container Ship	14796	164	Panama	1997
417	9330496	UNI FORTUNA	Container Ship	36000	239	Panama	2007
418	9202156	UNI PACIFIC	Container Ship	17887	180	Panama	1999
419	9202168	UNI PATRIOT	Container Ship	17887	182	Panama	1999
420	9202209	UNI POPULAR	Container Ship	17887	181	Panama	2000
421	9202247	UNI PROSPER	Container Ship	17887	182	Taiwan	2001
422	9114517	UNIRICH	General Cargo	5552	98	Belize	1994
423	9356414	UNISKY	General Cargo	6269	132	Antigua Barbuda	2006
424	9188673	UNIWISDOM	General Cargo	8036	115	Belize	2006
425	9293234	URU BHUM	Container Ship	24955	194	Thailand	2005
426	8917687	VAI SUN	Container Ship	18000	178	Liberia	1990
427	9216729	VASI MOON	Container Ship	16850	168	Liberia	2000
428	9336359	VEGA FYNEN	Container Ship	9966	147	Liberia	2006
429	9330252	VEGA KAPPA	Container Ship	9966	148	Liberia	2007
430	9486271	VF GLORY	General Cargo	6491	118	Panama	2008
431	9673666	VIOLETA B	Container Ship	18826	170	Cyprus	2014
432	9293246	VIRA BHUM	Container Ship	25000	195	Thailand	2005
433	9433054	VITA N	Container Ship	18334	175	Cyprus	2010
434	9722039	VIYADA NAREE	Bulk Carier	24235	182	Singapore	2016
435	9146895	VTC SUN	Bulk Carier	14743	154	Vietnam	1996
436	9048574	WAN HAI 211	Container Ship	17138	175	Singapore	1993
437	9048586	WAN HAI 212	Container Ship	17138	175	Singapore	1993
438	9059145	WAN HAI 216	Container Ship	17138	175	Singapore	1994
439	9208150	WAN HAI 231	Container Ship	17751	191	Singapore	2000
440	9493250	WAN HAI 271	Container Ship	16776	172	Singapore	2011
441	9493274	WAN HAI 273	Container Ship	16776	172	Singapore	2012
442	9182019	WAN HAI 281	Container Ship	17609	173	Singapore	1998
443	9509803	WARNOW BOATSWAIN	Container Ship	17068	180	Cyprus	2011
444	9437256	WARNOW CARP	Container Ship	9650	139	Cyprus	2009
445	9449857	WARNOW CHIEF	Container Ship	17068	180	Cyprus	2009
446	9449833	WARNOW MASTER	Container Ship	17068	180	Cyprus	2009
447	9149902	WEHR BLANKENESE	Container Ship	16177	184	Marshall Island	1999
448	9505558	WESERBORG	General Cargo	6668	107	Netherlands	2011
449	9146869	WORLD WINNER	General Cargo	6154	100	South Korea	1996
450	9566411	XIN XIANG HAI	Bulk Carier	31754	190	Panama	2012

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451	9321471	YANKI A	Container Ship	27915	215	Malta	2006
452	9353280	YM EFFICIENCY	Container Ship	42741	269	Liberia	2009
453	9353278	YM ENHANCER	Container Ship	42800	269	Liberia	2009
454	9353292	YM ETERNITY	Container Ship	42741	269	Liberia	2009
455	9331086	YM INSTRUCTION	Container Ship	16488	172	Liberia	2007
456	9319105	YM INVENTIVE	Container Ship	16488	173	Liberia	2007
457	9100504	YON DA 9	General Cargo	6641	99	Panama	1994
458	9041837	YONG TONG 1	Chemical Tanker	7916	132	Panama	1991
459	8814299	ZHONG XIANG	General Cargo	10629	150	Liberia	1992
460	9333060	ZHONGGU SHANDONG	Container Ship	36000	222	China	2007
461	9391268	ZIM DALIAN	Container Ship	40030	260	Malta	2009

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Motto: "finish what you start"

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