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Research on measures to accelerate the implementation of Ballast Water Management Convention, 2004

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RESEARCH ON MEASURES TO ACCELERATE THE IMPLEMETATION OF BALLAT WATER MANAGEMENT CONVENTION, 2004

By

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A research paper submitted to the World Maritime University in partial Fulfillment of the requirements for the award of the degree of

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2014

Dedicated to:

My beloved wife, Zeng Ying

and

My 3 year-old daughter, Yang Zengzeng, who is found with autism

Declaration

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

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

(Signature): Yang Zhe

(Date): 10 July 2014

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Professor of Dalian Maritime University

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Title: **Research on Measures to Accelerate the Implementation of Ballast Water Management Convention, 2004**

Degree: **MSc**

Abstract

Since the 1870s, ballast water has been used on board to maintain balance and stability by steel hulled vessels and it has become one of the main carriers of invasive marine species and pathogens from one part of the world to another. There are already hundreds of serious invasions of marine species and pathogens being recorded around the world, such as *Mitten Crab* that invaded Western Europe, *North American Comb Jelly* that entered into the Black sea and *Asian Kelp* appeared in Southern Australia, which caused or are causing serious damage to local biodiversity, environment protection, economic development and even human health.

Threats from ship ballast water to environment, economy, ecology and human health by invasive marine species and pathogens are growing with the increase of international seaborne trade. However, ten years have passed since the *International Convention for the Control and Management of Ships' Ballast Water and Sediments* (the BWM Convention) was adopted and the BWM Convention has not come into force yet. What's more, the pace of international community to ratify the BWM Convention is gradually slowing down especially in recent years, though the International Maritime Organization, again and again, calls on States to ratify, accept, approve or accede to the BWM Convention as soon as possible

On one hand, it is the growing threat from ballast water; on the other hand, it is the slowdown of the implementation of the BWM Convention. Why it happens? Can this situation be improved? In order to promote the implementation of BWM Convention as soon as possible and to protect our marine ecological environment security, this

paper aims to find the main barriers and root causes that impede the implementation of BWM Convention and finally suggest possible measures that IMO can take to accelerate the implementation of BWM Convention.

Key words: Measures; Accelerate the implementation; Ballast water management convention

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List of Abbreviations

BLG The Sub-Committee on Bulk Liquids and Gases

BWE Ballast Water Exchange

BWM The International Convention for the Control and Management of Ships' Ballast Water and Sediments

BWMS Ballast Water Management System

BWPS Ballast Water Performance Standard

BWTS Ballast Water Treatment System

BWWG Ballast Water Working Group

CCS China Classification Society

EIF Enter Into Force

GBP GloBallast Partnerships

IACS International Association of Classification Societies

IAPH International Association of Ports and Harbors

IMO International Maritime Organization

MEPC Marine Environment Protection Committee (of IMO)

MSC Maritime Safety Committee (of IMO)

PSC Port State Control

PSPC Performance Standard for Protective Coatings

TRC Treatment Rated Capacity

UNCED United Nations Conference on Environment and Development

UNCLOS United Nations Convention on the Law of the Sea

USCG United State Coast Guard

WHO World Health Organization

WSSD World Summit on Sustainable Development

Chapter I Introduction

With the development of economic globalization and world trade, ship size is much larger, ship number is much bigger and ship speed is much faster. Unfortunately, the result is that there is much more ballast water on load and discharged among different ports and that the risk of invasive marine species and pathogens spread by ballast water is much higher.

The invasion of alien marine species and pathogens may result in great threats on local biodiversity, environment protection, economic development and even human health. It has been recognized as one of the greatest threats to the world's oceans and great ecology damages and huge economic losses have been faced by many countries or regions that have been invaded by alien marine species and pathogens such as Great Lakes (*European zebra mussel, Ruffe* and *Round goby*), Australia (*European shore crab*, *Northern pacific kelp* and *Giant fan worm*) and Black Sea (*American ctenophore*) (IMO, 2014a).

Perhaps, the most effective measure to control, minimize and eliminate the risk of invasion of alien marine species and pathogens is the implementation of BWM Convention on a global level. However, one of the greatest characters of the BWM Convention is forward-looking, which means that, at the time of adopting of the BWM Convention, there were lacking technology support and uniform and practical guidelines. Therefore, many States have been hesitating to ratify the BWM

Convention. At present, there are already some Ballast Water Treatment Systems (BWTS) which have been approved by IMO and Administration. Also Guidelines have been established by IMO. However, the reality is that the possibility of more States, especially States which sharing bigger world tonnage, ratifying the BWM Convention is much lower than expected, and that the specific day for its implementation is still full of uncertainty.

1.1 Background and overview of the BWM Convention

1.1.1 Ballast water

Ballast refers to any solid or liquid substances that are added to the ship to control the trim, list, draft, stability or stresses of the ship, reduce the hull pressure, improve ship propulsion, and enhance maneuvering ability, which plays an important role in navigation safety. In water, any substance is affected by gravity and buoyancy. To stabilize the vessel, in wooden ship period, rocks, sand or metal were the main materials that were used as ballast. Only after the 1870s, with the appearance of iron hulled ships and steel hulled ships, did water begin to be used on board as "ballast water". During World War II, the use of ballast water instead of rocks, sand or metal became the mainstream.

Compared to rocks, sand or metal, ballast water can be either taken in or discharged when the ship is navigating at sea or when the ship is berthing in port. Great convenience is brought to the world shipping thank to the use of ballast water. The most common case of ballast water use is to make up for the changing weight caused by loading or discharging of cargos. The ship may need to take ballast water in when it starts its voyage for no cargo loading or not fully loading and may have to discharge ballast water when it reaches its destination for cargo loading. In addition, loading or discharging of ballast water may be also very necessary when the ship is navigating in bad weather. Especially if the ships have deeper draft, in their routine cargo loading and transporting period, loading or discharging of ballast water happens frequently on

board.

The amount of ballast water transferred each year is very huge. It is reported that, each year, over 80% of the world's commodities are transported by ship, with about 3 to 5 billion tonnages of ballast water being transferred internationally at the same period. In addition, each year, a similar amount of ballast water may be transferred by domestic ships within countries and regions (GBP, 2014).

1.1.2 Invasive marine species

With the convenience of ballast water brought to world shipping, a serious threat on environment, ecology, economy and health threat may be imposed. This kind of threat often results from introduction of invasive marine species and pathogens. At the same time, this kind of threat is often referenced by people and compared with oil pollution or other kinds of traditional marine pollution. Compared with traditional pollution, the pollution caused by invasive marine species has some special and unique features.

(1) Difficult to be found. Unlike the intentional introduction of species and as the side effects of world shipping, the unintentional introduction of invasive marine species and pathogens is very difficult to be found. In addition, the alien marine species introduced by ballast water are difficult to be seen by eyes directly, as they are mainly bacteria, pathogens and microorganism etc.

(2) Irreversible. Irreversible is the most essential feature of marine biological pollution. As once invaded by alien marine species or pathogens, local region usually cannot completely eliminates them.

(3) Repeated enhancement. In many countries or regions, there are ships running just between two ports. In this case, as the ballast water is discharged into the same port again and again, the threat of invasive species and pathogens coming from the other port is repeated.

(4) “Cross invasive” (Global). As shipping is international, this port’s polluted water may be carried to other ports, thereby creating and causing global threat and the “cross invasive”.

(5) Wideness of serious impacts. The serious impacts of marine biological pollution may be spread over every aspect, such as biodiversity, environment, economic and human health.

The following lists the specific explanations of wideness of serious impacts caused by marine biological pollution.

Firstly, it threatens the biodiversity. With the discharging of untreated ballast water, more and more alien species invade regional ports or sea. Some invasive marine species rapidly breed by crazy feeding local species. Some invasive marine species crow out or kill local species by robing or possessing the living rooms and resources. For example, *undariap innatifid* is a kind of alga which originates in north Asia. Years ago, it invaded into South Australia and has replaced the local seabed alga (Dang et al., 2001).

Secondly, it threatens the ecological environment. Red tide is the main presence of marine ecological pollution caused by ballast water. Most of the invasive marine species have strong ecological adaptability. Once they adapt to the new environment, they spread crazily. If the environment is appropriate, the red tide very easily happens, which may seriously threaten the stability of local ecological system and even destroy the local marine ecological system.

Thirdly, it threatens the economic development. The destruction of biodiversity and environment may result in enormous economic loss in the tourism industry, fishing industry, transporting industry and other relevant marine industry. The indirect or potential loss caused by marine biological pollution is even more serious and difficult to estimate.

Fourthly, it may threaten human health. On one hand, some invasive marine species may make local species poisonous. For example, *Dinoflag ella*, which can result in red tide and has invaded many countries, can be eaten by filter-feeding shellfish, such as *oysters*. When the polluted *oysters* are eaten by human, the poison produced by *Dinoflag ella* can result in paralysis or death (which is called as *paralytic shellfish poisoning*). Australian scientists attributed the introduction of *Dinoflag ella* to the discharge of ballast water (Dang et al., 2001). On the other hand, the pathogens carried by ballast water can result in great threat to public health. For example, the *cholera,* which broke out in 1991, resulted in a total of more than 10000 deaths. It is estimated that it was introduced into Peru by ballast water from Asia (Ke, 2013).

1.1.3 The global response

As early as 1903, when there was a mass occurrence of the Asian phytoplankton algae *Odontella (Bidulpphia) sinensis* in the North Sea, it was the first time that the scientists that realized the phenomenon of marine invasive species (Stephan, 1997). In later decades, few countries did more detailed research on this matter. However, it was not until the 1970s when A Cholera epidemic (disease agent: *Vibrio cholerae*) broke out in Peru, that the World Health Organization (WHO) first verified the potential of ballast water in transferring unwanted species and the issue was reviewed in detail (Guan, 2008).

In the 1973 IMO conference, the issue of ballast water, especially about the issue that harmful pathogens were transferred by ballast water, was discussed and a resolution was made in this conference, which identified the potential of ballast water in transferring harmful pathogens and resulting of the spread of the epidemic and requested the IMO and WHO to collect relevant evidence and suggestions from member States and to do more detailed research (Dang et al., 2001).

Even though *the 1982 United Nations Convention on the Law of the Sea* (UNCLOS) had realized the hazard of introducing of alien or new species, there was only a very

general article (Article 196) describing that “States shall take all measures necessary to prevent, reduce and control…introduction of species, alien or new, to a particular part of the marine environment…”. No detailed measures or guidelines were established from the 1982 UNCLOS.

Later, as there was an increasing trend of transferring invasive species by ballast water, more and more countries were experiencing particular problems with invasive species. Among these countries, Australia was the first country to bring this problem into focus and has established several control mechanisms. In the late 1980s, Australia and Canada submitted to MEPC proposals on ballast water control mechanism. In 1990, a special ballast water group was established in IMO. In 1991, the first *Guidelines for preventing the introduction of unwanted organisms and pathogens from ships' ballast water and sediment discharges* was adopted by IMO by MEPC resolution 50 (31).

In 1992, the *United Nations Conference on Environment and Development* (UNCED) also recognized this issue as a major international problem and requested IMO to consider the adoption of appropriate rules on ballast water discharge to prevent the spread of non-indigenous organisms (UN, 1992).

In 1993, resolution A.774 (8), *Guidelines for preventing the introduction of unwanted organisms and pathogens from ships' ballast water and sediment discharges*, was adopted, after reviewing the ballast water investigation report which was conducted by 13 States and was submitted by Australia. This resolution was not just a renewal of MEPC resolution 50(31), but has a higher lawful status and with a view to develop internationally applicable, legally-binding provisions. Resolution A.774 (8) requested the MEPC and MSC to keep the ballast water issue and the application of the above Guidelines under review with a view to further developing the Guidelines as a basis for a new Annex to MARPOL 73/78 (IMO, 1993).

With more and more member States and non-governmental organizations joining the ballast water work group and more and more proposals being submitted to IMO, the

provisions on ballast water control were in great development. In 1997, resolution A.868 (20), *Guidelines for the Control and Management of Ship's Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens*, was adopted by IMO conference. Compared to previous Guidelines, resolution A.868 (20) contained more kinds of means on ballast water management and States can choose to use by national legislations.

As these Guidelines were not global binding and there were great differences on means of ballast water management, great difficulties came out on implementation by shipping industry and States. The character of voluntary was far less than the need to encounter the serious threat raised by introduction of invasive marine species. Furthermore, several states have taken individual actions to control ballast water. In order to establish a globally and uniformly applicable regulation, a special draft group was established by IMO in 1999.

In 2002, *World Summit on Sustainable Development* (WSSD) has a promotion effect requested on the convention making and in item (b) of paragraph 34 of the *Plan of Implementation of the World Summit on Sustainable Development*, it requested to "accelerate the development of measures to address invasive alien species in ballast water" and it urged "the International Maritime Organization to finalize its draft International Convention on the Control and Management of Ships' Ballast Water and Sediments" (UN, 2002).

As the special character of bio-invasive, which is different from the traditional pollution, after years of great discussions and negotiations, the intended globally binding regulation was not regulated as a part of the MARPOL, but became an independent convention. On February 2004, *the International Convention for the Control and Management of Ships' Ballast Water and Sediments* (BWM Convention) was adopted by IMO at a Diplomatic Conference in London.

1.1.4 Content of the BWM Convention

1.1.4.1 Structure of the BWM Convention

The BWM Convention consists of two parts: the main body of the BWM Convention and the Annex (the BWM regulation). Twenty-two articles are included in the main body of the BWM Convention. There are five sections in the Annex (the BWM regulation), in which the technical requirements are listed. The Annex forms an integral part of the BWM Convention. A reference to the BWM Convention constitutes, at the same time, a reference to the Annex (IMO, 2014b).

The Articles of the main body of the BWM Convention are as follows: Definitions; General Obligations; Application; Control of the Transfer of Harmful Aquatic Organisms and Pathogens Through Ships' Ballast Water and Sediments; Sediments Reception Facilities; Scientific and Technical Research and Monitoring; Survey and Certification; Violations; Inspection of Ships; Detection of Violations and Control of ships; Notification of Control Actions; Undue Delay to Ships; Technical Assistance, Co-operation and Regional Co-operation; Communication and information; Dispute Settlement; Relationship to International Law and Other Agreements; Signature, Ratification, Acceptance, Approval and Accession; Entry into Force; Amendments; Denunciation; Depositary; Languages.

The full name of the BWM regulation is *Regulations for the Control and Management of Ships' Ballast Water and Sediments*. The five sections of the BWM regulation are as follows: General Provisions; Management and Control Requirements for Ships; Special Requirements in Certain Areas; Standards for Ballast Water Management; Survey and Certification Requirements for Ballast Water Management.

1.1.4.2 Control and Management Requirements

(1) Management options and discharge standard of ballast water.

According to BWM Convention and *Guidelines*, generally, there are three options for ballast water management, including:

- *Ballast Water Reception Facilities*;
- *Ballast Water Exchange*;
- *Ballast Water Treatment*.

In these management options, the requirement for the *Ballast Water Reception Facilities* is not mandatory, and therefore the ***Ballast Water Exchange*** and ***Ballast Water Treatment*** are the two main options of ballast water management. The following gives a brief introduction of the two main options.

1)***Ballast Water Exchange*** refers to the requirements that the ballast water uploaded in the port of departure shall be exchanged to the water in the deep sea before reaching the port of destination, with the theory that some aquatic organisms carried in the deep sea water, which discharge into the sea of reception port, are not easy to survive due to the differences of living conditions and thus reduce or eliminate the adverse impacts on the local port.

2)***Ballast Water Treatment*** refers to the uploaded ballast water, before being discharged into another port, which should be treated by killing or extinguishing aquatic organism. It should be ensured that survival rate of the aquatic organism is lower than designated limit standard and could not cause adverse effects to the receiving port waters.

(2) The corresponding standards to the two management options are as follows:

1)D-1 Standard: ***Ballast Water Exchange Standard***

2)D-2 Standard: ***Ballast Water Treatment Standard,*** also referring to ***Ballast Water Performance Standard***

The D-2 Ballast Water Performance Standard of BWM Convention is shown in Table 1.

Table 1: Ballast Water Performance Standard (D-2 Standard)

Viable Organisms	**Number**		**Indicator microbes**	**acceptable concentration**
≥50 μm	<10/m^3		Toxicogenic *Vibrio cholerae*	<1cfu/100ml or <1 cfu/g zooplankton samples
≥10 μm and <50 μm	<10/ml		*Escherichia coli*	<250 cfu/100ml
			Intestinal Enterococci	<100 cfu/100ml

Source: IMO. (2004). *BWM Convention.*

As the *Ballast Water Exchange* is restricted by weather, sea and geographical conditions, to the BWM Convention, the *Ballast Water Exchange* is only a transitional management measure. The final purpose of the ballast water management is that the ballast water must be treated meeting the D-2 standard before being allowed to discharge. At present, the main approach to reach this goal is treating ballast water by installing *Ballast Water Management System* (BWMS), which has got type approval by Administration, on vessels.

1.1.4.2 D-1 and D-2 Implementation Scheme

According to B-3 of the BWM Convention, the original implementation scheme was as Table 2.

Table 2: The original implementation scheme

Date of Ship Construction, C	**Regulation**	**Ballast Water Capacity (M^3), B**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
C < 2009	B-3.1.1	1500≤B≤5000	D1/D2						D2			
	B-3.1.2	B <1500 or B >500	D1/D2								D2	
C≥2009	B-3.3	B<5000	--	D2								
2009 ≤ C < 2012	B-3.4	B ≥5000	D1/D2								D2	
C≥2012	B-3.5	B ≥5000	--				D2					

Source: IMO. (2004). *BWM Convention*.

However, in order to make wide, effective and smooth implementation of the BWM Convention, the application timetable of D-2 has been revised by IMO's resolutions: A.1005 (25) and A.1088 (28).

The A.1005 (25) provided an understanding only for those ships constructed in 2009. "A ship subject to regulation B-3.3 constructed in 2009 will not be required to comply with regulation D-2 until its second annual survey, but no later than 31 December 2011". （IMO, 2007）. The A.1005 (25) has been revoked by A.1088 (28). The latest revised D-2 implementation scheme by A.1088 (28) is shown in Table 3.

Table 3: The latest revised implementation scheme according to the entre-into-force (EIF)* of the BWM Convention

Date of Ship Construction, C	**Regulation**	**Ballast Water Capacity (M^3), B**	**deadline for the implementation of D2**
C < 2009	B-3.1.1	1500≤B≤5000	EIF≥2014: by the first renewal survey for IOPP** Certificate following the date of entry into force of the Convention
			EIF<2014: by the first renewal survey for IOPP Certificate following the anniversary date of delivery of the ship in 2014
	B-3.1.2	B <1500*** or B >5000	EIF≥2016: by the first renewal survey for IOPP Certificate following the date of entry into force of the Convention
			EIF<2016: by the first renewal survey for IOPP Certificate following the anniversary date of delivery of the ship in 2016
2009≤C < EIF	B-3.3	B<5000***	by the first renewal survey for IOPP Certificate following the date of entry into force of the Convention
2009 ≤ C < 2012	B-3.4	B ≥5000	EIF≥2016: by the first renewal survey for IOPP Certificate following the date of entry into force of the Convention
			EIF<2016: by the first renewal survey for IOPP Certificate following the anniversary date of delivery of the ship in 2016
2012≤ C < EIF	B-3.5	B≥5000	by the first renewal survey for IOPP Certificate following the date of entry into force of the Convention
C≥EIF		All vessels***	should comply with the D-2 standard on delivery

(*) "*EIF*" means "enter-into-force" of the BWM Convention.

(**) "*IOPP renewal survey*" refers to the renewal survey associated with the International Oil Pollution Prevention Certificate under MARPOL Annex I.

(***) Survey and certification are required only for vessels of 400GT or more, excluding Floating platform, FSU and FPSO.

Source: IMO. 2013. *A.1088 (28)*.

1.1.4.3 Technical Guidelines

In the convention, there are many provisions depicted as "taking into account the Guidelines developed by the Organization". 2004 BWM conference resolution 1 invited IMO to develop these Guidelines as a matter of urgency with a view to uniform implementation of the BWM Convention (IMO, 2014c). A program for development of the guidelines was approved on the MEPC 51 and subsequently revised and updated, such as during MEPC 53. To date[1], 14 guidelines related to the 2004 BWM conference resolution 1 have been developed and adopted. However, the *Guidelines for Port State Control under the 2004 BWM Convention*, which MEPC required FSI to develop as early as October 2004 (Zhang et al., 2009) and has been extended for several times, with the purpose to harmonize Port State Control activities and to define criteria for a detailed inspection of the ship (Article 9 in the Convention), is not approved by MEPC, but still in progress (MEPC, 2014).

Table 4: List of Guidelines for the uniform implementation of the BWM Convention

Number	Title	Resolution	Reference to BWM Convention	Status
G1	Guidelines for sediment reception facilities	MEPC.152(55)	Article 5	
G2	Guidelines for ballast water sampling	MEPC.173(58)	Article 9, 1 c)	
G3	Guidelines for ballast water management equivalent compliance	MEPC.123(53)	Regulation A-5	
G4	Guidelines for ballast water management and development of ballast water management plans	MEPC.127(53)	Regulation B-1	
G5	Guidelines for ballast water reception facilities	MEPC.153(55)	Regulation B-3, 6	
G6	Guidelines for ballast water exchange	MEPC.124(53)	Regulation B-4, 1.1	

[1] To the date of the dissertation is prepared: 1 June 2014.

G7	Guidelines for risk assessment under regulation A-4 of the BWM Convention	MEPC.162(56)	Regulation A-4, 1.4	
G8	Guidelines for approval of ballast water management systems	MEPC.174(58)	Regulation D-3, 1	Revokes MEPC.125 (53)
G9	Procedure for approval of ballast water management systems that make use of active substances	MEPC.169(57)	Regulation D-3, 2	Revokes MEPC.126 (53)
G10	Guidelines for approval and oversight of prototype ballast water treatment technology programs	MEPC.140(54)	Regulation D-4, 2	
G11	Guidelines for ballast water exchange design and construction standards	MEPC.149(55)	Regulation B-1	
G12	Guidelines on design and construction to facilitate sediment control on ships	MEPC.209(63)	Regulation B-1, 3	Revokes MEPC.150 (55)
G13	Guidelines for additional measures regarding ballast water management including emergency situations	MEPC.161(56)	Regulation C-1, 3.1	
G14	Guidelines on designation of areas for ballast water exchange	MEPC.151(55)	Regulation B-4, 2	
	Guidelines for port State control under the 2004 BWM Convention	MEPC […]	Article 9	Target completion year:2015

Source: IMO MEPC 66/INF.2 (29 October 2013); IMO PPR 1/16 (12 February 2014).

More detailed contents of these *Guidelines* and other technical documents can be attained from IMO's *IMODOCS* website: http://docs.imo.org/Default.aspx.

1.1.5 Status of the BWM Convention

According to Article 18 of the BWM Convention, it will enter into force 12 months after ratification by 30 States, representing 35 per cent of world merchant shipping tonnage.

Since 31 May 2005, the BWM Convention had been open for accession by any State.

The situation of States on ratification of the BWM Convention is shown in Table 5.

Table 5: Statistics on States that have ratified the BWM Convention

Year	Number of States	Represent world's tonnage of merchant ships
2005	4	/
2006	0	/
2007	10	3.42%
2008	16	14.24%
2009	21	22.63%
2010	27	25.32%
2011	32	26.46%
2012	36	29.07%
2013	38	30.38%

Source: www.imo.org. (2014). Compiled by the author.

To date[2], 38 States have acceded to or ratified the BWM Convention, only representing 30.38% of the world's tonnage of merchant ships. Though the number of Contracting Governments has met the requirements, the representing tonnage is not sufficient. Therefore, the BWM has not come into force yet.

The 38 States that have ratified the BWM Convention are as follows: Albania, Antigua & Barbuda, Barbados, Brazil, Canada, Cook Islands, Croatia, Denmark, Egypt, France, Germany, Iran (Islamic Republic of), Kenya, Kiribati, Lebanon, Liberia, Malaysia, Maldives, Marshall Islands, Mexico, Mongolia, Montenegro,

[2] To the date of the dissertation is prepared: 1 June 2014.

Netherlands, Nigeria, Niue, Norway, Palau, Republic of Korea, Russian Federation, Saint Kitts and Nevis, Sierra Leone, South Africa, Spain, Sweden, Switzerland, Syrian Arab Republic, Trinidad & Tobago and Tuvalu. It can be seen that most of these States that have ratified the BWM Conventions are States which own relatively smaller ship fleet but suffer from larger amounts of ballast water discharging.

Figures 1 and 2 analyze the trend of states on ratifying the BWM Convention in the number of States and percentage of world's tonnage of merchant ships by year. It can be concluded that the initiative of States that have not ratified the BWM Convention to ratify the convention has almost totally disappeared.

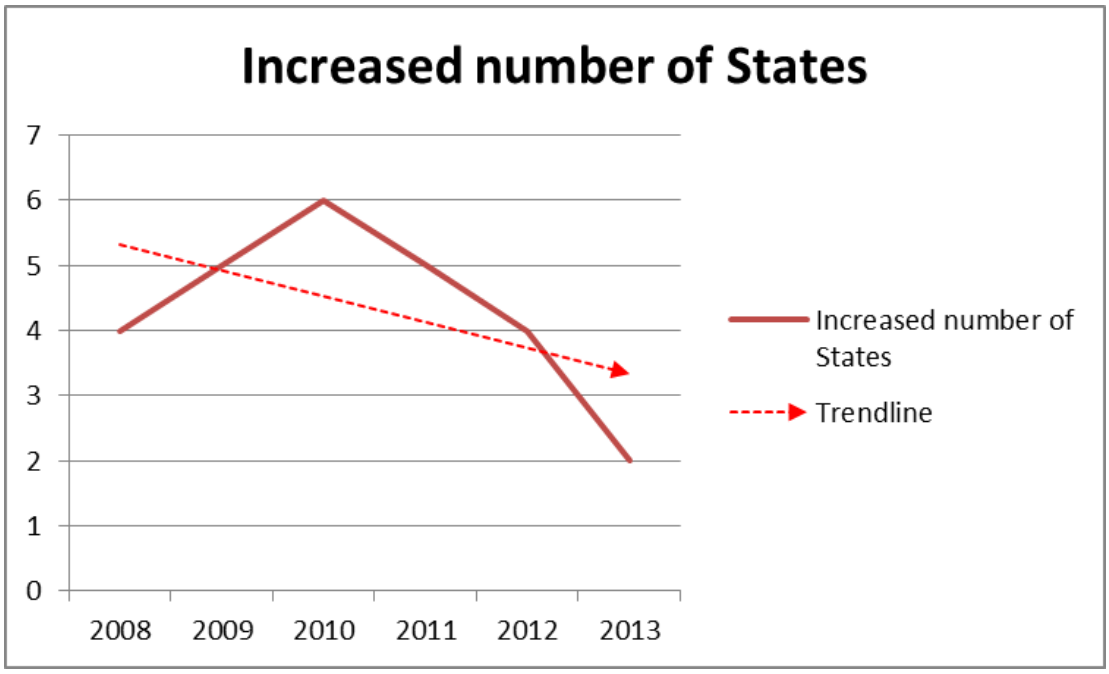

Figure 1: Trend analysis on increased number of States on ratifying the BWM Convention by year

Source: Compiled by the author.

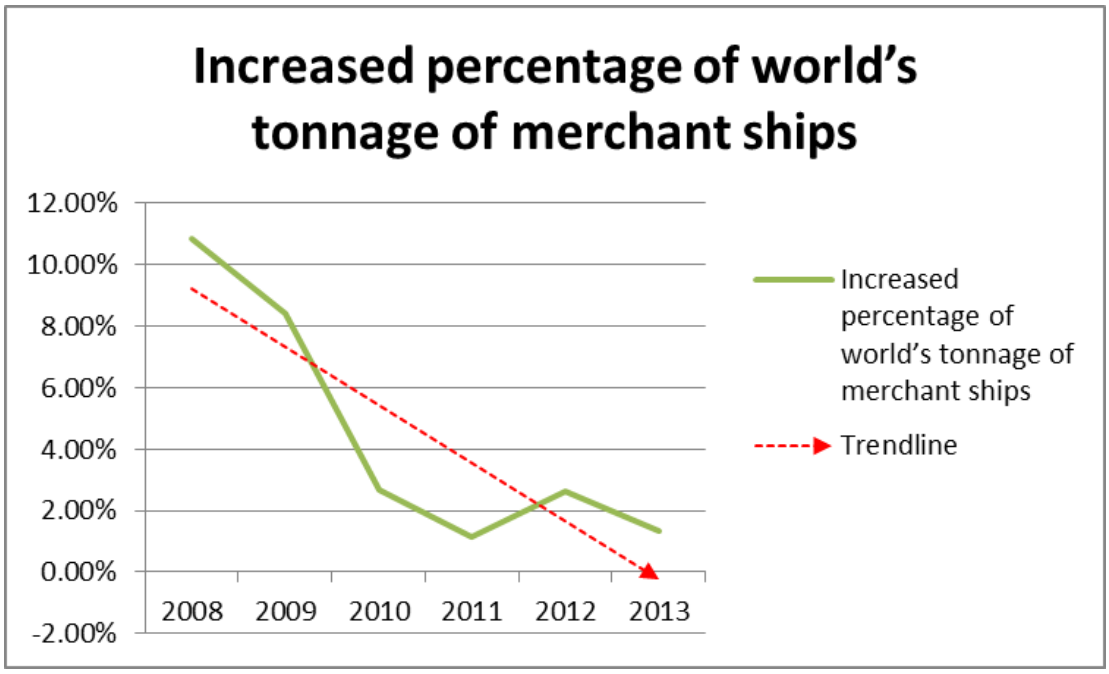

Figure 2: Trend analysis on increased percentage of world's tonnage of merchant ships on ratifying the BWM Convention by year

Source: Compiled by the author.

1.2 Objective of the study

The purpose of this thesis is to introduce the history progress of the development of the BWM Convention, identify the main barriers on tis implementation faced by the marine industry, analyze the root causes of these issues, study the latest discussions and give some suggestive measures in accelerating its implementation.

1.3 Research Methodology

The literature research method, which is widely used in various kinds of research work, is used in this dissertation. Based on the purpose of finding the measures to accelerate the implementation of BWM Convention, the author obtains comprehensive and correct understanding on this subject, by reviewing the literature material.

The second research methodology used in this dissertation is the problem analysis

method. In the first step, the problem is identified by checking whether there are deviation between the actual situation and the required standard. Secondly, further analysis is conducted to find the root causes. In the third step, the author puts forward possible suggestions to solve the problem accordingly.

1.4 Presentation Order

This dissertation is organized in a logical order and constituted by six parts. A brief introduction was given in the first Chapter, including the background and the overviews of the BWM Convention as well as the main methodologies that have been used in this dissertation. Then in Chapter Two, the previous research to accelerate the implementation of BWM Convention and their limitations are discussed. Chapter III mainly identifies the main barriers that hinder the implementation of BWM Convention. The root causes of these barriers are further and comprehensively analyzed in Chapter IV. Chapter V is the core of this dissertation in which suggestions on the acceleration to the Implementation of the BWM Convention are given. Brief summary and final comments are provided in Chapter VI.

Chapter II Literature Review

2.1 Previous research to accelerate the implementation of BWM Convention

2.1.1 The research status abroad

There are many research reports about ballast water issue abroad. Stephan Gollasch performed a critical review on BWM Convention and Guidelines from perspectives of biological, shipping and regulatory concerns and pointed out the challenges on global implementation of BWM Convention. Challenges faced by the shipping industry for effective implementation of the BWM Convention were also identified by Mr. P.K. Mishra in technical point of view, such as the need of revision of G8, sampling and analysis and availability and sufficiency of BWMSs. Challenges to effective implementation of the BWM Convention are also identified by some Member States of IMO. Liberia, the Marshall Islands, Panama, BIMCO, INTERTANKO, CLIA, INTERCARGO, InterManager, IPTA, NACE and WSC submitted a proposal to IMO and believed that the problem existing in G8 and sampling and analysis procedures for port State control purposes are the main challenges. In addition, some other non-government organizations, such as IACS[3] and IAPH[4], also have done much research in this subject and put forward some suggestions.

[3] International Association of Classification Societies
[4] International Association of Ports and Harbors

2.1.2 The domestic research status

To date, little research about ballast water issue has been done concerning how to promote the implementation of BWM Convention. Research has mainly focused on what China should do if the convention enters into force. Another focus of research work by scholars is ballast water treatment technology, such as electrolytic treatment of ships' ballast Water conducted by Dangkun. In addition, application of the risk assessment technology to ballast water problem is also conducted by some researchers, such as Ke Junxian. However, Professor Zhang Shuohui does a lot of deep research on how to better implement of BWM Convention on a global scale.

2.2 Limitations of the previous research

According to the previous research, it can be concluded that most of the research on the implementation of BWM Convention is focused on the specific technologies on ballast water treatment or identification of the challenges that hinder the implementation of BWM Convention. All the previous research has provided a useful insight into the identification of ballast water barriers. However, the process of barrier analysis and suggestions given is not very sufficient and comprehensive. In-depth analysis of the root causes and the design of practical and useful measures to accelerate the implementation of BWM Convention on a global scale as early as possible is the final aim of this dissertation.

Chapter III The BWM Convention's Implementation Barriers

IMO currently has 170 Member States and three Associate Members[5]. Up to June 1st 2014, 38 States have ratified the BWM Convention, representing 30.38% of the world's tonnage of merchant ships[6], which is only 4.68% less than the requirement for its entry into force. However, according to the introduction of Chapter I, it can be seen that the initiative of States that have not ratified the BWM Convention to ratify the convention has almost totally disappeared. The affecting factors on whether and when a State to ratify the BWM Convention are many and very different. In order to facilitate in-depth analysis of the root causes impeding the implementation of the BWM Convention, this section aims to provide an overview of the major barriers.

According to this study, the author does not try to list all the challenges, but to identify the most important factors. The major barriers that are affecting ratification and effective implementation of the BWM Convention are identified as the following:

3.1 Concerns on the maturity of BWMSs

(1) Are there enough kinds of BWMSs received approval around the world?

(2) Are the existing BWMSs suitable to all kinds of ships?

(3) Is the manufacturing and ship yards' capacity sufficient for installation to ships in

[5] Source: www.imo.org.
[6] Source: IHS-Fairplay -World Fleet Statistics 31 December 2012.

limited time period?

(4) Are you sure that the installation of approved BWMSs can meet the Port State Control requirements if the seafarers maintained these equipment without fault?

(5) Are you sure all these present BWMSs can satisfy “Five Requirements” (Safe, Practical, Effective, Cost-effective, Environment friendly)?

(6) How to deal with the relationship with individual action and higher standards taken by some individual States?

3.2 Fairness issues in its implementation

Some States and companies express great worries about that improper competition that may be caused by some countries use of additional measures.

3.3 Consideration of the economic interests

Economic reason is the most direct problem facing shipping companies if the BWM Convention is in its implementation.

3.4 Lack of sufficient awareness on ballast water problem

The developing and underdeveloped countries do not have the sense of urgency of biological invasion phenomenon.

Chapter IV Analysis of the Causes of Barriers

The previous chapter identified the main factors in four aspects hindering the implementation of the BWM Convention. In order to put forward effective suggestions on accelerating the implementation of the BWM Convention, this chapter will do further analysis and try to find the root causes of these barriers in detail.

4.1 Analysis on the maturity of BWMSs

The technical problem is the core issue on this matter. All through the way, the shipping industry is very worried about whether the seemingly mature BWMSs can really reach the D-2 standard. Especially, some of the BWMSs manufacturers had originally planned to eliminate the ship owners' worries at the 2012 SMM[7] meeting in Hamburg, Germany. However, as there were two kinds of BWMSs, which have been approved and marketed, being reclaimed by the manufacturer for technical problems, the concerns on maturity of BWMSs have again increased from the shipowners (Xu, 2012).

4.1.1 Availability of BWMSs

Due to the high technical difficulty, the need of layers of approval, the high cost of research and certification as well as the unclear market foreground, there are high risk

[7] SMM is the leading international forum of the maritime industry. Every two years, the representatives of the shipbuilding and marine equipment industries from all parts of the world meet in Hamburg, present innovations and forward looking technologies, and set the course for future success of the industry. Source: http://smm-hamburg.com/en/exhibitors/.

behind the opportunity of BWMSs project. Those BWMSs manufacturers who spend a lot of time and money to develop BWMSs have to experience the approval process. Although there have been new technologies and equipment entering into the stage of testing, only a few BWMSs are entitled to the approval and allowed to enter the market.

According to materials given by Manufacturers of BWMSs and public database printed by Lloyd's Register, there are about 60 Manufacturers (not more than 100) producing or planning to produce BWMSs (CCS, 2012). However, by the end of 2013, 44 kinds of BWMS that make use of Active Substances had received Basic Approval from IMO, 31 kinds of BWMSs that make use of Active Substances had received Final Approval from IMO and 33 kinds of BWMSs (including 11 kinds of BWMS that No Active Substances used) had received Type Approval Certification by their respective Administrations[8].

What's more, among the 170 Member States and three Associate Members of IMO, only about 15 States' BWMSs receive the Basic Approval, Final Approval or Type Approval. The 15 States are as follows: Republic of Korea, Japan, Germany, China, Netherlands, Norway, Singapore, Sweden, South Africa, Greece, Denmark, Marshall Islands, Malta, United Kingdom, and Hellenic Republic. Only a few States own their own manufacturing BWMSs and most other States do not have their own manufacturing BWMSs.

Today, the availability of BWMSs is still limited.

4.1.2 Suitability of BWMSs

The suitability of BWMSs to different types of ships is another practical problem that troubles the shipowners and shipyards.

[8] Source: MEPC 66/INF.2.

On the one hand, in terms of the specific ship, the installation of BWMSs is directly or indirectly related to its operating characteristics, ballast water treatment requirements, available equipment installation cabin space, total capacity of ballast water tanks, displacement of ballast water pump, power supply, and the rest of the ship's system coordination and operation requirements, etc. For new building vessels, if these problems are considered in ship design, it may be suitable. But for existing ships which don't consider the installation of BWMSs when they were under construction, it's to foist into a complete set of equipment into the original layout of the ship. On the other hand, in terms of BWMS, as a kind of new product, ballast water treatment technology is developing. Although there are BWMSs that have been put into use, but, so far, the experience has still been limited. Each kind of BWMSs has its own or special characteristics. For example, the BWMSs that use the method of electrolysis are not useful in fresh waters, the BWMSs that use the ultraviolet devices are limited in larger turbidity waters, and the BWMSs that use the chemical and deoxidizing method need more reserve time of ballast water which may not be applicable for short voyages. In addition, suitability of BWMSs to the ships with larger ballast water capacities and special vessels (such as unmanned barges, semi-submersibles and heavy lift crane vessels) is still under discussion.

Based on the above various reasons, at present, there is hardly a treatment system that can be applicable to all ships.

4.1.3 Adequacy of BWMSs and shipyards

In fact, this issue has always been discussed by MEPC and Member States. Many States express their concerns on this problem. Due to limitation of installation space, piping layout and other factors, there are many difficulties for existing ships selecting and installing BWMSs. Shipowners have always been hesitant in installation of BWMSs and take a wait-and-see attitude.

According to the data collected and number estimation of installation of BWMSs by

Japan in 2011, only a small number of vessels had installed BWMSs while a large number of ships would install BWMSs during 2015 and 2019 as shown in Figure 3 (MEPC, 2011).

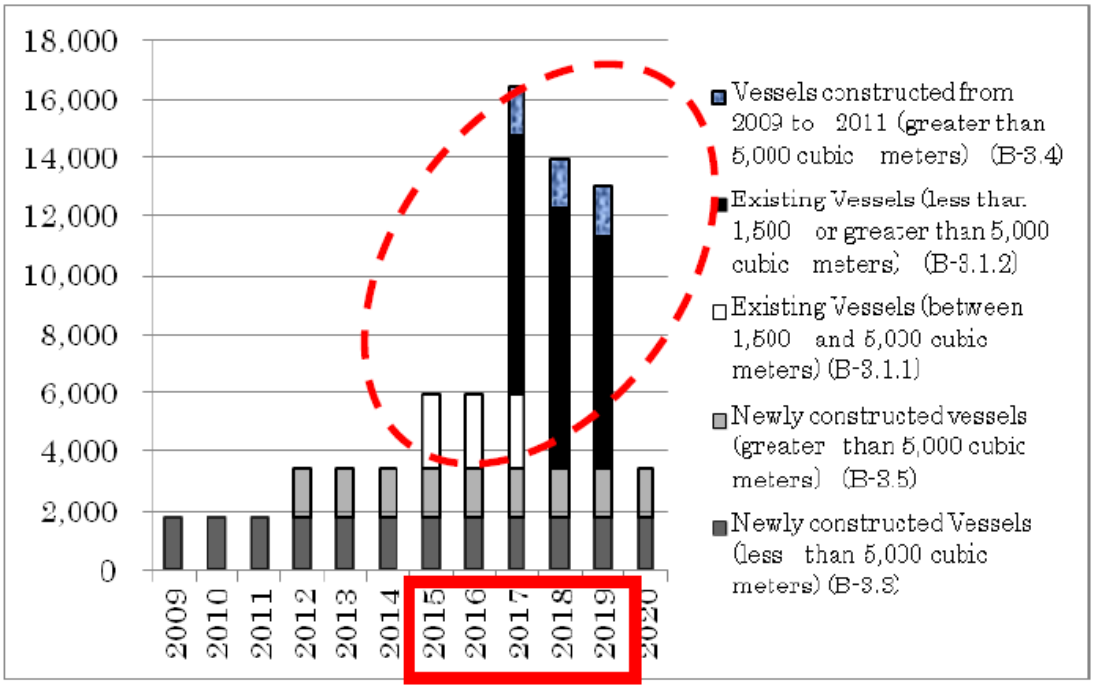

Figure 3: Estimated number of vessels required to install BWMS

Source: MEPC 61/2/17. (2010)

However, the above estimation is based on the implementation scheme at that time. At the end of 2013, the IMO plenary approved A.1088 (28), which recommended that ships constructed before the entry into force of the Convention will not be required to comply with regulation D-2 until their first renewal survey for IOPP Certificate following the date of entry into force of the BWM Convention, at the 28th session of the IMO Assembly.

For shipowners, this means that compliance with the Convention is postponed until their first renewal survey for IOPP Certificate following the date of entry into force of the BWM Convention, rather than ships having to comply after a fixed date.

But a new problem may appear. As most shipowners take a wait-and-see attitude and

the linkage of implementation of D-2 standard with the renewal survey for IOPP certificate, once conditions for entry into force are met, for some ships the deadline for compliance with the D-2 standard could be as soon as the entry into force of the convention.

Therefore, though there is more time left to the shipowners to choose the appropriate type of BWMS for installation, which solved the uncertainty problem, it also means that a large number of vessels will install BWMSs between the first year and the sixth year (as according to Article 18, it shall enter into force twelve months after the conditions are met) since the conditions for entry into force are met. For example, if the conditions for entry into force are met in 2015, the peak of installation will concentrate between 2015 and 2021. Later the number will sharply drop.

The problem not only exists in adequacy of BWMSs, but also in adequacy of shipyards. On the one hand, according to the current approved BWMSs and the present situation of these BWMSs, the manufacturing capacity cannot meet the increasing demand in designated period. On the other hand, another more important problem is that the concentrated installation demand of BWMSs will have a lot of pressure for dockyards supply. This is because that all the installations of BWMSs are needed to be completed in shipyards in designated time period. There will be a great shortage on shipyards for such a large number of ships waiting for installation. For example, it is reported by exports in Republic of Korea that the manufacturing capacity of their country can meet the demand of half of world of BWMSs, but the number of shipyards available for BWMSs installation is far away to meet this demand. In addition, the installation of BWMSs will need a large number of professional and technical personnel. The manpower will also be in a great shortage.

4.1.4 The matching between the results of PSC and BWMSs

This issue is considered by many experts or scholars as one of the most important factors of restricting the implementation of BWM Convention. The following are the

reasons for this worry:

Firstly, unsolved sampling issue has great influence on PSC. Though the G2 "*Guidelines for ballast water sampling*" was adopted on 10 October 2008 by Resolution MPEC.173 (58), the core issue of the sampling and analysis procedures for port State control purposes is still unsolved. There exists the problem that the standard for port State control sampling and analysis is inconsistent with the standard for approval of the BWMSs. At present, G2 is just considered as a transitional guideline. Just as the G2 writes that "The sampling and analysis methodologies to test for compliance with the Convention are still in development. Although significant technical advances and refinements have been made in these areas since the adoption of the Convention, there are still numerous issues to be resolved" and that "At the present time, there are no specific sampling or analysis protocols that can be recommended for Administrations to use".

Secondly, there are concerns over the actual operation performance of BWMSs. Though the approval of a system is intended to screen out BWMS that would fail to meet the D-2 standards, however, according to the present Guidelines, such as G8, the BWMSs are not tested in all types of waters, such as the high salinity water, fresh water and sediments rich waters. Just as the Liberia, the Marshall Islands, Panama, BIMCO, INTERTANKO, CLIA, INTERCARGO, InterManager, IPTA, NACE and WSC indicated in their proposal that "the approval documentation may imply that the BWMS has no practical and operational limitations. However, the fact that no limitations are provided does not mean limitations do not exist" and that "Approval, however, does not ensure that a given system will work in compliance with the discharge standard once installed on board and operated in the actual maritime environment"(MEPC, 2012).

Many shipowners associations and several States with flag of convenience express great worry about the potential of the properly used and maintained Type Approved BWMSs being found non-compliant and further leading to detain of the ship.

4.1.5 The compatibility of BWMSs

"Safe, Practical, Effective, Cost-effective, Environment friendly", there is no denying that IMO put forward these "Five Requirements" about ballast water treatment years ago. At present, there are more than a dozen of ballast water treatment technologies around the world. In theory, the perfect solution should be accessed. But the reality is that each single technology has more or less deficiency in the aspects such as safety, compliance and economy. These "Five Requirements" makes the standard of ballast water treatment system become in appearance easy but in practical difficult to deal. Until today, no system has been able to satisfy all these "Five Requirements" and all types of vessels.

There are several specific examples about this issue. One is that the compatibility of the BWMSs with the coating issue. Some organizations indicated that the ballast water treatment technology using active substance may have an adverse effect upon the ballast tank coating. The Resolution MSC.215 (82) "*Performance Standard for Protective Coatings for Dedicated Seawater Ballast Tanks in All Types of Ships and Double-side Skin Spaces of Bulk Carriers*" provides details on the Performance Standard for Protective Coatings (PSPC). However, the reality is, just as the co-sponsors[9] stated in the proposal MEPC 64/2/18, that "the current corrosion and coating impact tests undertaken by BWMS manufacturers frequently fall well short of the standards established in the PSPC" and that "Some coatings have only been subjected to the Active Substance doses over short (6 to 8 weeks) periods as opposed to a more thorough period of more than 6 months" (MEPC, 2012).

4.1.6 Unilateral action and higher standards

Though the condition of entry into force of the BWM Convention is still not reached, in order to protect their own environment, some States have taken unilateral action to

[9] The co-sponsors refer to Liberia, the Marshall Islands, Panama, BIMCO, INTERTANKO, CLIA, INTERCARGO, InterManager, IPTA, NACE and WSC. Source: MEPC 64/2/18.

control ballast water discharge through domestic legislation. Ships are required to exchange ballast water in mid-ocean and hold the approved "Ballast Water Management Plan". Some States even establish higher standards than that of IMO.

(1) USA

On 28 August 2009, in the United States Coast Guard's (USCG) Notice of Proposed Rule Making (NPRM), which was published on Federal Register (74 FR 44632)[10], the USCG proposed a two-phase approach of ballast water management implementation scheme. The proposed phase - one ballast water treatment standard is the same as D-2 of BWM Convention. The proposed phase - two standard is 1,000 times more stringent than the phase - one standard and contains standards for very small viruses and bacteria cells. In addition, apart from the two-phased approach, there are two different federal statutes and various state approaches, which even higher than the USCG standard.

However, the U.S. Coast Guard ultimately compromised with the 100 times or even 1000 times more stringent discharge requirements and decided to adopt the standard which was equivalent to D-2 standard of IMO. The U.S. Coast Guard Final Rule on "Standards for Living Organisms in Ships' Ballast Water Discharged in U.S. Waters[11]" was published in the Federal Register on 23 March 2012 and became effective on 21 June 2012.

According to the Final Rule, Ballast Water Exchange Standard and Ballast Water Performance Standard (equal to D-2 standard) are the two kinds of acceptable methods of ballast water management in USA at present. The specific Ballast Water Performance Standard implementation schedule is shown in table 6 (USCG, 2012).

[10] The full test can be found from the website: http://www.uscg.mil/hq/cg5/cg522/cg5224/docs/USCG-2001-10486-0138.pdf.
[11] Full text of the Final Rule can be found on the Federal Register website at: www.gpo.gov/fdsys/pkg/FR-2012-03-23/pdf/2012-6579.pdf.

Table 6: Implementation schedule for approved ballast water management methods (USCG)

	Vessel's ballast water capacity	**Date constructed**	**Vessel's compliance date**
New vessels	All	On or after December 1, 2013	On delivery
Existing vessels	Less than 1500 m^3	Before December 1, 2013	First scheduled drydocking after January 1, 2016
	1500-5000 m^3	Before December 1, 2013	First scheduled drydocking after January 1, 2014
	Greater than 5000 m^3	Before December 1, 2013	First scheduled drydocking after January 1, 2016

Source: USCG. (2012).

According to the new Ballast Water Discharge Standard, if manufacturers want to get U.S. Coast Guard's approval of BWMSs, Independent Laboratories (ILs) are required to be used to perform the testing and support applications for approval. However, until now, only a few of these manufacturing enterprises of BWMSs that have received final approval by IMO have taken testing in independent and professional lab for approval. Most of their experiment platforms are built or formed on their own labs or jointed labs for testing. If these new requirements take effect, many manufacturers would withdraw from the competition in the market.

In addition, the USCG ballast water management requirements implementation scheme causes an inconsistency with the new D-2 implementation scheme adopted by IMO's Assembly Resolution A.1088 (28), which may lead to the difficulty and confusion for ships.

It is also very notable that the USCG will continue to review the existing BWMSs and publish the review results before 1 January 2016.

(2) Australia

Australia is one of the earliest countries to implement the ballast water management.

On July 1, 2001, mandatory ballast water management requirements were introduced by Australia to international vessels. These requirements are enforceable under the *Quarantine Act 1908* and the latest version is "*Australian Ballast Water Management Requirements* (Version 5)[12]". The requirements are based on risk assessment mechanisms (high-risk and low-risk) that take into consideration factors such as ship type, departure port and safety etc. The acceptable ballast water exchanges must achieve at least a 95% dilution of high-risk ballast water with clean seawater from the deep ocean. Ballast water exchange calculations are required and examples are listed by the requirements. Ships' deck, engineering and ballast water management logs are usually checked in inspection to verify ships' compliance of ballast water management requirements.

(3) Other States

Brazil has made mandatory national legislation pertaining to requirements for ballast water since 2006. In BWM.2/Circ.1, it states:

> All ships intending to discharge ballast water into Brazilian jurisdictional waters shall conduct ballast water exchange at least 200 nautical miles from coast and in water at least 200 meters in depth. In cases where the ship is unable to conduct ballast water exchange as stipulated above, it shall be done as far as possible from the nearest land and in all cases at least 50 nautical miles from the coast and in water at least 200 meters in depth[13]…

Like Brazil, many other States or regions like Canada, Norway, Colombia, Lithuania and Argentina also have taken similar ballast water management requirements. Thought the convention has not become into force yet, the D-1 has been taken into

[12] The full test can be found on the website: www.daff.gov.au.
[13] More detail can be found from: BWM.2/Circ.1.

consideration by most of these States.

4.2 Analysis on fairness issues in its implementation

Fairness is another key element that the State takes into consideration, especially among the undeveloped and developing countries.

4.2.1 Worries about technology monopoly

At present, the Ballast Water Treatment Technology is high technology. Though there are requirements about "*Technical Assistance, Co-operation and Regional Co-operation*" in Article 13 of BWM Convention, the potential of technology monopoly is still very high, as the final purpose of companies of BWMSs manufacturers is to make profit and get back the very high early capital invest. As shown in Table 7, the present BWMSs that have received approval are mainly owned by developed countries and several developing countries and few underdeveloped countries.

Table 7: Allocation of States that own BWMS that received Basic Approval, Final Approval or Type Approval

Proposing Country	Received Basic Approval from IMO	Received Final Approval from IMO	Received Type Approval from their respective Administrations*
Republic of Korea	16	11	7
Japan	6	5	4
Germany	5	5	2
China	4	2	4
Netherlands	3	2	1
Norway	3	3	8
Singapore	2	0	0
Sweden	2	0	0
South Africa	1	1	1
Greece	1	1	0
Denmark	1	1	1
Marshall Islands	0	0	2
Malta	0	0	1
United Kingdom	0	0	1
Hellenic Republic	0	0	1

* Including 11 kinds of BWMS that no Active Substances used.

Source: MEPC 66/INF.2. (2013).

4.2.2 Worries about unfair competition

In fact, this reason is perhaps the very underlying but important reason for some States or companies to consider.

On the one hand, the initiative to introduce the ballast water management requirements of ships may make its ports economically disadvantaged as the operating cost for entering their ports becomes higher. On the other hand, the ballast water management requirements may lead to the possibility that some States or big shipping companies may use the policy of ballast water management to protect their own interests and make the small shipping companies or foreign shipping companies

to withdraw from the competitive market.

Firstly, at present, the shipping industry is in intensive competition and low profit period. As to most of the small shipping companies, the installation of BWMSs maybe means losing their competitive edge and even the bankruptcy of small shipping companies.

Secondly, the Convention does not prevent any country from taking more stringent measures, individually or jointly with other Parties, to establish a higher protection level against species introductions, just as the Regulation C-1 of BWM Convention states:

> If a Party, individually or jointly with other Parties, determines that measures in addition to those in Section B are necessary to prevent, reduce, or eliminate the transfer of Harmful Aquatic Organisms and Pathogens through ships' Ballast Water and Sediments, such Party or Parties may, consistent with international law, require ships to meet a specified standard or requirement…

Though there are provisions to regulate these additional measures, the possibility still exists that this policy may be used by some States to drive some shipping companies out.

In addition, another possibility is that the policy may be used by some States damaging the shipping interests of other States to protect their own marine environment. By summing the characters of States that have ratified the BWM Conventions or taken individual actions, it can be concluded that most of these countries are small States with bigger port sea areas and smaller ship fleet.

4.3 Analysis on economic interests

Firstly, in a state, the government, on one hand, wants to protect the marine environment, on the other hand, has the obligation to protect the shipping companies' sustainable development, especially, for some developing states which own larger shipping fleets.

Secondly, the ballast water treatment technologies are high technologies. High technologies mean high investments. It is estimated that the installation of BWMS per ship is about one to five million US dollars. For a state that has 1000 international vessels, the installation cost purse is about one billion to five billion. This does not include the maintaining and operational cost. If these costs are added, the real cost is much higher.

Thirdly, in order to avoid technology monopoly and price monopoly, and also to reduce installation and maintaining cost, each state wants to have their own BWMSs.

In addition, the global economic crisis which began from 2008 also has a great adverse influence for some States in the process of ratifying the BWM Convention. In order to avoid bankruptcy, many shipping companies are cutting their operating cost. The result is that any extra cost will be subtracted from their budget, which leads to the negative attitude towards implementation of BWM Convention.

4.4 Analysis on public awareness on ballast water problem

Firstly, many countries, especially developing and under-developed countries take the economic interests as the first priority and ignore the environmental protection, especially the biological invasion issue which is not easy to be found and limited by regulatory method. This issue is not listed as the most urgent problem in these countries.

Secondly, usually the introduction of non-indigenous species is unintentional. As the

difficulty of realization of the introduction of invasion of alien species, if there are no specific regulations or effective education or training, the prevention is also very difficult to implement.

Thirdly, hysteresis of biological invasion affects people's attention on the ballast water problem. The phenomenon of biological invasion by ballast water is different from the traditional environmental pollution, such as oil. The outbreak of epidemic pathogen may be very quick but most kinds of biological invasion will not immediately produce their destructive results. There are usually four stages before the destructive results appear: invasion, adaptation, growth and reproduction. Several years or even ten years or even more time are taken for this process (Li, 2013).

In addition, the media and the public usually focus more on the traditional marine environment pollution, such as oil and chemical. This is one of the main reasons why most people's consciousness of invasion of alien species by ballast water is so weak. The weak consciousness of prevention of invasion of alien species by ballast water is also one of the reasons why many States take a wait-and-see attitude.

Chapter V Suggestions on the acceleration to the Implementation of the BWM Convention

5.1 Global mandatory implementation of D-1 standard as priority

According to the analysis of Chapter IV, it can be concluded that, as the technical reason, there is great difficulty for global mandatory implementation of D-2 standard before some core technical issues are solved. However, there is the urgency of taking actions to prevent the transfer of harmful organisms and pathogens around the world and to lower the possibility of inconsistent regional implementation of ballast water standard. This may add extra burden for ships' compliance and increase the difficulty of effective global uniform implementation. Therefore making the D-1 standard global mandatory implementation will be one of the most effective measures that make the BWM Convention's entry into force.

Firstly, D-1 standard is perhaps the most practical way at present, as most ships can meet this requirement. Though shipping studies have proven that the effectiveness of ballast water exchange is limited and in certain instances, such as in shallower seas or during high organism concentrations, after an exchange more organisms were found (Gollasch et al, 2007) and that "*a 95% volumetric exchange of water may not always be equivalent to a 95% organism removal as the organisms are not homogeneously distributed in a tank*" (Murphy et al, 2002). However, as most ships can conduct ballast water exchange, in order to achieve the aim of the BWM Convention, the D-1

standard should be taken by ships whenever possible and until BWMS has been installed on ships.

Secondly, many states have mandatory implementation of D-1 standard through domestic legislation. Just as analyzed in Chapter IV, at present many states have mandated implemented the D-1 standard, such as Australia, Canada, Brazil, Norway, Colombia, Lithuania and Argentina. And some States even implement more stringent standards. These countries unilateral action has accelerated the inconsistent implementation of ballast water management requirements in world wide. Taking the D-1 standard into global mandatory implementation is the need of the trend of ballast water management, which may promote the ratification of the BWM Convention.

Thirdly, there are several regional co-operations on voluntary implementation of D-1 standard, such as the North East Atlantic Ocean and Baltic Sea region (mainly including the Contracting Parties to the OSPAR and Helsinki Conventions)[14] and Mediterranean Sea region (mainly including the Contracting Parties to the Barcelona Convention)[15]. This kind of voluntary implementation of D-1 standard support bases to D-1 standard's global implementation.

Fourthly, there is relatively mature and perfect management and inspection experience. Take Australia for example. The risk assessment mechanisms are established. All the management requirements are based on risk assessment. What's more, the calculation and inspection scheme is a necessary part of ballast water management requirements. There are also mature guidelines on implementation of the D-1 standard.

In addition, the characters of biological invasion need the global implementation of D-1 standard. On this matter David et al (2008) states that:

[14] The Contracting Parties to the OSPAR and Helsinki Conventions are as following: Belgium, Denmark, Estonia, Finland, France, Germany, Iceland, Ireland, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, the Russian Federation, Spain, Sweden, Switzerland and the United Kingdom.

[15] The Contracting Parties to the Barcelona Convention are as following: Albania, Algeria, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, the Libyan Arab Jamahiriya, Malta, Monaco, Montenegro, Morocco, Slovenia, Spain, Syria, Tunisia and Turkey.

> …from a biological perspective it does not at all make sense if one state implements BWM measures to avoid species introductions when a neighboring state ignores this problem, since after introduction species may migrate by their natural means and eventually reach neighboring jurisdictions (p, 6).

5.2 Enhancing Regional Co-operations

Co-operation is needed, because the problem of introduction of alien marine species will not stop at borders of states. Coordinating research would not only help to prevent duplication of work, but also to promote experience sharing and environment protection effectiveness regionally.

Firstly, like the co-operations such as North East Atlantic Ocean and Baltic Sea region, Mediterranean Sea region and Black Sea region, they are not meant to replace the requirements in BWM Convention, but to promote the first initiative of an interim ballast water management strategy-ballast water exchange. The obtained experience can be used to promote wider ratification of BWM Convention.

Secondly, rational use of concept of global ecological areas and division of these areas will play a positive role in promoting the ratification of the BWM Convention by States. Before BWMSs have been installed on vessels, in the same ecological area, the most effective biological pollution prevention measure perhaps is the application of ballast water exchange or exemption.

It is believed that effective regional co-operations will greatly promote the possibilities of more States ratification of the BWM Convention.

5.3 Keeping on assessment of the maturity of BWMSs

The final purpose of the ballast water management is that the ballast water must be

treated meeting the D-2 standard before being allowed to discharge. The implementation of D-2 standard is inevitable, but just a time issue. At the same time, appropriate postponing of D-2 standard, regular assessment of the maturity of BWMSs is very necessary.

In Chapter IV, six aspects of the maturity of BWMSs are included. Though there are some research papers about BWMSs, most of them are from pure technical point of view. Few assessments about maturity of BWMSs include all these six aspects (availability, suitability, adequacy, compatibility, the PSC compliance, individual action and higher standard). Therefore, a regular and comprehensive assessment, which includes at least all the six matters mentioned above, should be conducted and published worldwide supplying sufficient information to all the involved parties.

5.4 Speeding up the revision of Guidelines G2 and G8

As discussed in Chapter IV, in order to eliminate the limitations of the present Guideline G2, the revision of it should focus on providing specific, operational and global unified standard on sampling and analysis. Special attention should also be paid to the consistence of standard on sampling and analysis in G2 with the standard in G8, which means that the revision of G2 and G8 should be synchronized.

In addition, the following aspects should be attended to in the process of revision of G8. Firstly, the process of Type Approval should be more transparent and more detailed information of BWMSs in testing should be given. Secondly, the system's maximum treatment rated capacity (TRC) should be based on actual physical tests but not theoretical extrapolation. Thirdly, limitations or problems that exist in some circumstances, such as brackish and freshwater, should be fully listed in Type Approval Certificate and its enclosures. Fourthly, the Type Approval process should fully take into consideration the compatibility with other new developing IMO requirements such as coating and HAZID assessment requirements.

As for what to do about BWMSs that have already been approved under the current G8, the following suggestions are given:

Firstly, the principle of "*Old equipment, Old regulations; New equipment, New regulations*" is much recommended. The "*First generation equipment*", which means BWMSs that received Type Approval before the revised G8 and are installed in good faith prior to the entry into force of BWM Convention, should be grandfathered for the life of the ship or be treated as "*Prototype Ballast Water Treatment Technologies*", by which the similar Regulation D-4 can be applied. The D-2 standard shall cease to apply to that ship for agreed fixed period from the date of entering into force of the BWM Convention.

Secondly, there must be a consensus that the revision of G8 and ballast water management is not intended to penalize shipowners who in good faith fitted and conscientiously operate type-approved equipment correctly, but to monitor for diligent application of the BWM Convention requirements. During this fixed period as has been agreed, penalties should be limited to deliberate attempts at non-compliance.

5.5 Making workable Guidelines for harmonization of the implementation of BWM Convention

Most of the existing Guidelines are pure technical guidelines which lack systematic compiling and make flag state and port state difficult to widespread harmonized implementation of BWM Convention. In order to ensure widespread harmonized implementation of the BWM Convention, many lessons can be learnt from smooth implementation of other international conventions, such as the MLC, 2006.

Firstly, the two sets of Guidelines, "*the Guidelines for flag State inspections under the BWM Convention*" and "the Guidelines for port State control officers carrying out inspections under the BWM Convention" should be established to provide

authoritative guidance to assist countries to implement the BWM Convention.

Secondly, as an aid, in whole or in part, for national legislators and legislative counsel in drafting the necessary legal texts to implement the BWM Convention, "*the Guidance on implementing the BWM Convention - Model National Provisions*" should also be developed.

In addition, in order to ensure effective and unified implementation of port State control, the relevant requirements on ballast water management should be added to the "*Procedures for Port State Control, 2011*"[16], taking effect after the entry into force of the BWM Convention and promoting ships' implementation of this convention.

5.6 Limiting the right of setting a standard higher than D-2 in IMO

If one State sets a standard higher than that of IMO, the impact is on the world wide ship fleet, therefore a principle should be explicit that a State has the right to implement more stringent standard on their own State's ship fleet but the right of setting a standard that is higher than D-2 should be limited in IMO. The additional measures that can be set by State are these kinds of measures, such as reporting requirements. Only reasonably balancing the rights and obligations between Flag State and Port State, will there be more initiative in ratification on BWM Convention.

5.7 Encouraging States to develop their own BWMSs

It can be concluded that all these concerns about fairness and economic issues can be summarized by money problem and the balance between economic interests and environment protection interests. If all or most of the States have their own BWMSs, the installation cost will be greatly decreased, most of their concerns will be eliminated and their willingness to ratify the BWM Convention will be promoted.

[16] The full text can be found from IMO Assembly Resolution A.1052 (27).

Though in practice it is impossible for most States to have their own BWMSs in very near future, it is recommended that the function of IMO in co-operations between member States be played to encourage States to develop their own BWMSs. Another measure that can also be taken into consideration is to set a special reward fund on monetary incentive for BWMSs research.

5.8 Correctly handling the relationships between flag State and port State

There is a point of view that the BWM Convention is a port State convention. For example, on this matter Gollasch et al (2007, p. 588) states that:

> This Convention is a Port State Convention relating to a marine pollution or quarantine issue with unwanted aquatic organisms being discharged via ballast water into the receiving ports.

Supporters for this point of view believe that initiative of implementation is not in the Flag State but in the port State.

However, the author of this dissertation does not agree with this point of view. For most States, they are not only flag States but also port States at the same time.

As a flag State under the BWM Convention, it has the responsibilities and obligations in, at least, the following four aspects: Type Approval for BWMSs, approval for Prototype Ballast Water Treatment Technologies, approval for Ballast Water Management Plan and survey and certification.

As a port State under the BWM Convention, it has the responsibilities and obligations in, at least, the following aspects: Inspection ships' certifications and documents, sampling and analysis of ballast water, investigation and handling of violations, designating the BWE areas and risk assessment for exemptions.

In addition, in the specific implementation of BWM Convention, as the complexity of the technology, there is great potential of the existence of different understandings or opinions of technical requirements and even inspection results. Therefore effective communication and co-operation are indispensable. Both the flag States and port States should make efforts to correctly handle their relationships.

5.9 Enhancing public awareness through education and media

The spread of information about biological invasion and its prevention is an essential topic. The focus of education and media should be laid on this matter.

Firstly, as seafarers have direct relationship with shipping and the specific operation is done by them, training about BWM Convention and specific operating requirements should be conducted in shipping companies and in maritime universities or training institutions.

Secondly, governments should increase the investment on the knowledge propaganda about biological pollution and protection urgency, using the media, popular science books, textbooks, internet and publicity to raise public awareness of the ballast water issue.

In addition, though IMO and GloBallast have conducted a worldwide awareness campaign and have played an important role, but more work still should be done by this organization, such as increasing the number of training, changing the work methods and focusing on guiding Member State to conduct public training.

Chapter VI Conclusion

In conclusion, based on introduction of the background of ballast water problem and review of the literature research, four main factors hindering the implementation of the BWM Convention are identified in the technical, economical and awareness aspects.

By analyzing the causes of these barriers, the technical problem can be concluded as the core issue that impedes the entry into force of the convention. Accordingly, taking the global implementation of D-1 standard in priority and appropriately postponing the implementation of D-2 standard is recommended as the most effective measure to accelerate the implementation of BWM Convention.

However, the implementation of D-2 standard is inevitable and just a matter of time. In order to thoroughly solve this issue, another seven suggestions are given, such as enhancing regional co-operations, assessing the maturity of BWMSs, revising G2 and G8, making additional Guidelines, enhancing States to develop their own BWMSs and enhancing public awareness etc.

Nevertheless, the BWM Convention deals with biological invasion problem which is greatly different from traditional pollution protection issue. Though only 4.62% of the world's tonnage of merchant ships is needed to ratify the convention, the attempt to change the wait-and-see attitude of States, which have not ratified the convention, is still a difficult task.

It is believed that if all the suggestions given in this paper are fully considered by IMO, Member States and shipping companies, and further effective measures are taken, the implementation of BWM Convention will greatly speed up.

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