The impact of Ballast Water Management Convention on seafarers work practices

Phanuwat Phiwphan

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The impact of Ballast Water Management Convention on seafarers work practices

By

PHANUWAT PHIWPAN
Kingdom of Thailand

A dissertation submitted to the World Maritime University in partial fulfilment of the requirements for the award of the degree of

MASTER OF SCIENCE
In
MARITIME AFFAIRS
(MARITIME SAFETY AND ENVIRONMENT ADMINISTRATION)

2018
DECLARATION

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

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

(Signature): 
(Phanuwat Phiwphan)

(Date): 15th September 2018

Supervised by: Raphael Baumler PhD (Dr.)
Associate Professor
World Maritime University
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Thirdly, I have to express my gratitude to my seafarer friends and brothers and sisters to support me and respond to my dissertation interview questionnaire. My research may not have been accomplished if I had not commented and answered from seafarers’ experience in the BWM operation. Especially, the harmony among Thailand Merchant Marine Training Center brothers has supported me to complete my dissertation.

Fourthly, I express my gratitude to the University’s faculty to teach and educate me in the knowledge of maritime affairs and international maritime administration.

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ABSTRACT

Title of Dissertation:  The impact of Ballast Water Management Convention on seafarers work practices

Degree:  MSc

This dissertation intends to assess the impacts of Ballast Water Management Convention (BWMC) on seafarers work practices. Indeed, since the entry into force of the BWMC, seafarers have to comply with numerous Convention’s requirements usually without additional manpower.

Seen primarily as an additional workload by seafarers, the implementation of BWMC on board ships also entails new types of risks which are directly related to the management of BW according to required standards.

The BWM Convention details two standards for mitigating the risk of invasive species. These are D-1 (Ballast Water Exchange) and D-2 (Ballast Water Performance Standard, often considered as ballast water treatment).

Currently, most ships comply with BWE (D-1) standards because they do not possess Ballast Water Management Systems (BWMS) on board able to reach D-2 Standard. However, D-1 is considered as an interim solution and after September 2024 all ship will have to comply with D-2.

The research surveyed seafarers to understand their practices and views when dealing with BWMC.

In this respect, the research showed that BWE (D-1) operations significantly increase workload on seafarers and require their additional knowledge to operate. When conducting BWE, seafarers also have to consider ship safety in the work practice.

Concerning ships complying with the D-2 standard, the installation and operation of BWMS requires special knowledge. Indeed, treatment processes require harmful and toxic processes and demand specific knowledge on risks and limits of BWMS. While BWMS is supposed to facilitate work to comply with BWMC, it seems BWMS reliability needs special attention as reported during the survey.

Finally, the survey shows that shipping company do support enough seafarers training and education on BWM operations and the basic requirements of the Convention.

KEYWORDS: Ballast Water Management Convention, Seafarer work practices, BWM convention impact.
# TABLE OF CONTENTS

DECLARATION .................................................................................................................. ii

ACKNOWLEDGMENTS ................................................................................................. iii

ABSTRACT ....................................................................................................................... iv

TABLE OF CONTENTS .................................................................................................. v

LIST OF TABLES ............................................................................................................. vii

LIST OF FIGURES ......................................................................................................... ix

ABBREVIATIONS ............................................................................................................ xi

Chapter 1 Introduction ................................................................................................. 1

1.1 Background .............................................................................................................. 1

1.2 Aims .......................................................................................................................... 2

1.3 Objectives .................................................................................................................. 3

1.4 Research Methodology .......................................................................................... 3
  1.4.1 Relating document review .................................................................................. 3
  1.4.2 Research population .......................................................................................... 3
  1.4.3 Data collection via questionnaire ....................................................................... 4
  1.4.4 Data analysis ....................................................................................................... 5
  1.4.5 Limitations of the study .................................................................................... 5

1.5 Scope of the study .................................................................................................... 6

Chapter 2 The Ballast Water Management Convention ............................................. 7

2.1 Introduction .............................................................................................................. 7

2.2 Ballast Water Management Convention requirements .......................................... 7

2.3 Risks related to Ballast water management methods .............................................. 9
  2.3.1 Ballast water exchange system ......................................................................... 9
  2.3.2 Ballast water management system .................................................................. 11

2.4 Elements of the convention affecting seafarers .................................................... 13
  2.4.1 Articles of the BWM Convention .................................................................... 13
LIST OF TABLES

Table 1 Involving BWM Convention to main stakeholders................................. 13
Table 2 Age of participant seafarers. ................................................................ 25
Table 3 Region of participant seafarers. .............................................................. 25
Table 4 Certificate of competency (COC) of participant seafarers....................... 26
Table 5 Last position of participant seafarers. ..................................................... 27
Table 6 Experience in last position of participant seafarers................................. 27
Table 7 Total seafarer experience of participant seafarers ................................... 28
Table 8 Role to engage in ballast water operation of participant seafarers.......... 30
Table 9 Experience of participant seafarer on officer in charge of ballast water..... 31
Table 10 BWE method used by participants....................................................... 32
Table 11 Maintenance and repair Ballast Water Management equipment .......... 33
Table 12 Training in Ballast Water Management Plan and procedure ............... 34
Table 13 Training in Ballast Water Record Book ............................................. 35
Table 14 Knowledge on basic requirement of Ballast Water Management Convention .................................................................................................................. 36
Table 15 Training in other topics related to Ballast Water Management .......... 37
Table 16 How does BWM convention affect to seafarer work load.................... 38
Table 17 How does BWM convention difficult to comply ................................... 39
Table 18 How are limitations of Ballast water operation ................................... 40
Table 19 Problem to comply D-1 standard......................................................... 41
Table 20 Comment on BW operation be dangerous .......................................... 43
Table 21 Source of ship inspection .................................................................... 44
Table 22 Method for removing sediment ........................................................... 45
Table 23 Role to engage in ballast water operation of participant seafarer .......... 49
Table 24 BWMS method which participants use D-2 ........................................ 50
Table 25 Maintenance and repair Ballast Water Management system D-2 ....... 51
Table 26 Reliability, strengths and weaknesses of BWMS ................................ 52
Table 27 Training in Ballast Water Management Plan and procedure D-2 ....... 54
Table 28 Training in Ballast Water Record Book ............................................. 55
Table 29 Knowledge on basic requirement of Ballast Water Management Convention D-2 ................................................................. 55
Table 30 Training in other topics related to Ballast Water Management D-2 ...... 56
Table 31 Training in the Ballast water management system D-2............................ 57
Table 32 How does BWM convention affect to seafarer work load......................... 58
Table 33 Limitation in Ballast water operation D-2........................................... 59
Table 34 Problem to comply D-2 standard.................................................................. 60
Table 35 Opinion on Ballast Water Management operation may be dangerous D-261
Table 36 Source of ship inspection D-2 ...................................................................... 61
LIST OF FIGURES

Figure 1 Timeframe to comply with D-2 standard .......................................................... 8
Figure 2 Ballast Water Exchange Methods ................................................................. 9
Figure 3 Unit operations and associate work activities for BWMS ............................ 12
Figure 4 A voyage approach to BWM control measure .............................................. 21
Figure 5 Familiarity with Ballast Water Management Plan ....................................... 29
Figure 6 Familiarity with Ballast Water Record Book ................................................. 30
Figure 7 Engaging in Ballast Water operations .......................................................... 30
Figure 8 Designated to be the officer in charge of Ballast Water Management .......... 31
Figure 9 Participants of training in Ballast Water Management plan and procedure .. 34
Figure 10 Participants of training in Ballast Water Record Book ................................ 35
Figure 11 Participants of knowledge on basic requirement of BWM convention ...... 36
Figure 12 Participants of training on other topics related to Ballast Water Management .......................................................... 36
Figure 13 Regulation on Ballast Water Management affect to seafarer workload ...... 37
Figure 14 Difficulties in complying with the Ballast Water Management Convention and Ballast Water Management Plan ............................................................. 38
Figure 15 limitation in Ballast water operation ............................................................. 39
Figure 16 Experience problem in applying D-1 standard ............................................. 41
Figure 17 Opinion on Ballast Water Management operation may be dangerous ...... 42
Figure 18 Be inspected experience on ballast water management requirements ...... 44
Figure 19 Engaging in sediments removal ................................................................. 45
Figure 20 Engaging in tank inspection ........................................................... 46
Figure 21 Familiarity with Ballast Water Management Plan D-2 ............................. 48
Figure 22 Familiarity with Ballast Water Record Book D-2 ....................................... 49
Figure 23 Participants of training in Ballast Water Management plan and procedure D-2 .......................................................... 54
Figure 24 Participants of training in Ballast Water Record Book D-2 ....................... 54
Figure 25 Participants of knowledge on basic requirement of BWM convention D-2  55
Figure 26 Participants of training in other topics related to Ballast Water Management D-2 .................................................................................................................. 56
Figure 27 Regulation on Ballast Water Management affect to seafarer workload D-2 .. 58
Figure 28 Difficulties in complying with BWM Convention and BWMP D-2 ............. 58
Figure 29 Opinion on Ballast Water Management operation may be dangerous D-2... 60
Figure 30 Be inspected experience on ballast water management requirements D-2.. 61
Figure 31 Addition medical surveillance .................................................................62
Figure 32 Engaging in sediments removal D-2 .........................................................63
# ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
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<tbody>
<tr>
<td>BWM</td>
<td>Ballast Water Management Convention (full title, International Convention for the Control and Management of Ships’ Ballast Water and Sediments)</td>
</tr>
<tr>
<td>BW</td>
<td>Ballast Water</td>
</tr>
<tr>
<td>BWMS</td>
<td>Ballast Water Management System</td>
</tr>
<tr>
<td>BWM</td>
<td>Ballast Water Management</td>
</tr>
<tr>
<td>BWMC</td>
<td>Ballast Water Management Convention</td>
</tr>
<tr>
<td>BWE</td>
<td>Ballast Water Exchange</td>
</tr>
<tr>
<td>BWTS</td>
<td>Ballast Water Treatment System</td>
</tr>
<tr>
<td>BWMP</td>
<td>Ballast Water Management Plan</td>
</tr>
<tr>
<td>BWRB</td>
<td>Ballast Water Record Book</td>
</tr>
<tr>
<td>BWRF</td>
<td>Ballast Water Record Form</td>
</tr>
<tr>
<td>CBD</td>
<td>Convention on Biological Diversity</td>
</tr>
<tr>
<td>COC</td>
<td>Certificate of competency</td>
</tr>
<tr>
<td>D-1</td>
<td>Ballast Water Exchange standard</td>
</tr>
<tr>
<td>D-2</td>
<td>Ballast Water Performance standard</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agriculture Organization of the United Nations</td>
</tr>
<tr>
<td>GEF</td>
<td>Global Environment Facility</td>
</tr>
<tr>
<td>GloBallast</td>
<td>Global Ballast Water Management Programme</td>
</tr>
<tr>
<td>GT</td>
<td>Gross tonnage</td>
</tr>
<tr>
<td>HAOP</td>
<td>Harmful Aquatic Organisms and Pathogens</td>
</tr>
<tr>
<td>IACS</td>
<td>International Association of Classification Societies</td>
</tr>
<tr>
<td>IBWM</td>
<td>International Ballast Water Management certificate</td>
</tr>
<tr>
<td>IGO</td>
<td>Inter Governmental Organization</td>
</tr>
<tr>
<td>ISM</td>
<td>International Safety Management Code</td>
</tr>
<tr>
<td>IOPP</td>
<td>International Oil Pollution Prevention Certificate</td>
</tr>
<tr>
<td>IMO</td>
<td>International Maritime Organization</td>
</tr>
<tr>
<td>MARPOL</td>
<td>International Convention for the Prevention of Pollution from ship</td>
</tr>
<tr>
<td>NGO</td>
<td>Non - Governmental Organization</td>
</tr>
<tr>
<td>Nms</td>
<td>Nautical miles</td>
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<tr>
<td>Acronym</td>
<td>Full Form</td>
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<tr>
<td>---------</td>
<td>-----------</td>
</tr>
<tr>
<td>MSDS</td>
<td>Material Safety Data Sheet</td>
</tr>
<tr>
<td>MEPC</td>
<td>Marine Environment Protection Committee</td>
</tr>
<tr>
<td>PSC</td>
<td>Port State Control</td>
</tr>
<tr>
<td>ROs</td>
<td>Recognized Organizations</td>
</tr>
<tr>
<td>ROB</td>
<td>Remaining On Board</td>
</tr>
<tr>
<td>SMS</td>
<td>Safety Management System</td>
</tr>
<tr>
<td>STCW</td>
<td>The International Convention on Standards of Training Certification and Watchkeeping for Seafarers</td>
</tr>
<tr>
<td>NK</td>
<td>Nippon Kaiji Kyokai</td>
</tr>
<tr>
<td>UNDP</td>
<td>United Nations Development Programme</td>
</tr>
<tr>
<td>UN</td>
<td>United Nations</td>
</tr>
<tr>
<td>USCG</td>
<td>The United States Coast Guard</td>
</tr>
<tr>
<td>UNCED</td>
<td>United Nation Conference on Environment and Development</td>
</tr>
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</table>
Chapter 1 Introduction

1.1 Background

Since the seaborne trade era, ships carry cargo around the world. In recent years, maritime transport continues to grow and take the largest share of global trade. This represents a cargo volume of about 10.3 billion tons in 2016, which in percentage represents over 80 percent of global trade by volume and above 70 percent by value (Hoffmann et al., 2017). Seaborne trade growth by multiplying ships and transportation induces externalities such as marine pollution and accidents.

The use of ballast water to balance ships is a 19th century evolution. Before, crew used rocks or other solid material to ballast their vessels. The main purposes of ballast water are to distribute weight on ships in order to maintain ship stability, to control ship stress under the limitation of ship structure, and to reduce air draft and ship trim (GloBallast, 2014-2017a).

Every year ballast water moves an estimate of 10 billion tonnes of water, including 7,000 species, around the world by ship (David & Gollasch, 2014). While, some species may not survive the trip inside ballast tank and new location, other species may adapt to the new environments and eventually cause damage (Mackenzie et al., 2017).

In recent years, invasive alien species are being considered as one of the most important threat to biodiversity including the effect in environmental, economic, and health.

Firstly, Harmful Aquatic Organisms and Pathogens (HAOP) contained in ballast water (BW) when released in new environment may endanger coastal ecosystems, change habitats, modify the food web and reduce local biodiversity (Mackenzie et al., 2017).
Secondly, the impact on overall economics includes reduction in fisheries’ productivity, threat on aquaculture and impacts on recreational activities relying on coastal ecosystems.

Finally, the threat to human health is that ballast water transfer may release toxic species (e.g. contaminating seafood) or virus/bacteria contamination, which have a direct and indirect effect on human consumers (GloBallast, 2014-2017b).

To control the risks caused by BW discharge, the International Convention for the Control and Management of Ship’s Ballast Water and Sediments (BWM Convention) has been established (IMO, 2016). The convention obligates ships to manage ballast water according to the Convention’s Standards D-1 (ballast water exchange) or D-2 (ballast water performance standards) (IMO, 2009).

The entry into force of the convention requires ships to comply with its standards. New standards signify modification of crew BW operation practices which, consequently, affect their workload. Such additional workload for a category of workers, which is already overload, may seriously impact their working and resting time. Indeed, it has been reported that a working period of more than 85 hours per week is not unusual (ITF website https://www.itfseafarers.org/ITI-fatigue.cfm). Fatigue generated by overwork also affects the Occupational Safety and Health (OSH) of individual workers as well as the whole ship safety.

Finally, each BWM standard (D-2) and (D-1) possess their inherent risks, which can affect workers.

In conclusion, the BWM Convention is the new instrument to solve the invasive alien species issue but have consequences for those applying the standards onboard ships.

1.2 Aims

This dissertation focuses on the factors influencing seafarers’ work practices but also health, safety, and workload. The main aim is to highlight the impacts of the Convention on seafarers and the difficulties to implement it on board ships with limited manning.
1.3 Objectives

- To evaluate the task relevant to the seafarer to comply with the BWM Convention.
- To find out the problems of the seafarer working process to comply with the BWM Convention.
- To propose the preparedness of the seafarer with the procedures to follow ballast water management plan.
- To advise the solution for balancing between the positive and negative impact of the BWM Convention on seafarer work practice.

1.4 Research Methodology

After a literature review and extraction from the Convention of each provision affecting work onboard ships, the data collection method focuses on interviews and questionnaires. The purpose is to gather the perspective and opinions of seafarers on the BWM Convention.

1.4.1 Relating document review

- Research the BWM convention and guidelines and identify aspects affecting seafarers' work practices.
- Research documents relating to ballast water treatment technology and the effect on user.
- Research documents relating to ballast water management methods and the necessary knowledge of seafarer working on ballast water management.

1.4.2 Research population

The total population in this research is twenty-five seafarers including deck and engine department.

The focus group is separated into two groups depending on the standard of the management systems onboard that are the D-1 BWE standard and D-2 Ballast water performance standard.
• All of the participants have a ranking officer onboard who shall have experience in an international voyage ship which has to comply with the BWM Convention.

• The D-1 group had twenty participant seafarers who have experience on Ballast Water Exchange (BWE) operations.

• The D-2 group had five participant seafarers who have experience on Ballast Water Management System (BWMS).

• The interviews are based on the interaction of seafarers working onboard or previously working onboard, who has no more than one year left.

1.4.3 Data collection via questionnaire

The questionnaire intends to collect general bio information, the understanding of BWM Convention, impacts on work practice, and any additional comments. The interview questionnaire is separated into two sets depending on the BWM method. The questionnaire is divided into 6 parts as follows.

Part 1 General information
This part consolidates information such as range of age, range of seafarers experience, and other information relating to experience on BWM operations.

Part 2 Ballast water operations and maintenance
This part relates to the experience of seafarers on BW operations and maintenance. The question requires a yes or no answer and asks for additional details on experience.

Part 3 Training and education
This part focuses on the training and education relating to BWM Convention. The answer about sources of knowledge is divided into five groups including self-learning, On-board training, Company training, Outsource training and other sources of training.

Part 4 Impact on work
This part investigates ballast water management tasks, issues and limitations on operations from seafarer experience of participants.
Part 5 Sediment operation/ Tank inspection

This part focuses on sediment removal and tank inspections.

Part 6 Others

This part is open-end questions asking about the BWM convention impact on seafarer work loads. Participants can give any comment or idea of ballast water management that affects the seafarer’s work or life.

1.4.4 Data analysis

This dissertation uses mixed qualitative and quantitative research instruments to analyse the work. The method to present data from the interview starts by categorizing data into a group of questions and presenting it in a figure or table.

To analyse the data from opinion and experience of the participant, the Phenomenological Analysis can be a research approach to present information of significant aspect.

The Phenomenological Analysis includes five steps as follows

- Describing a personal experience of a participant without the opinion of the researcher.
- Creating a list of significant statements from a participant’s opinion by avoiding repetitive and overlapping statements.
- Grouping significant statements with the same meaning together into larger units and describe what the participants experienced.
- Describing experiences of the participants
- Writing a comment and describing the phenomenon from an experience of participants in every significant aspect.

(Creswell, J. W., 1998)

1.4.5 Limitations of the study

The number of participants was limited to 25 persons because there were difficulties to find participants who have experience on this topic.
The time frame to conduct this research is restricted in the period of the Masters degree of WMU, which has a due date on 18 September 2018.

Moreover, the obstruction in distance and time zone between a source of information (network of author) and author restricts the interview time and the access to seafarers.

1.5 Scope of the study

To achieve the objective, this dissertation consists of 4 chapters. Chapter 1 has a detailed background, objectives, research methodology and scope of study.

Chapter 2 is the literature review. It informs the impact of the BWM convention which affects on the maritime industry and the importance of eliminating Harmful Aquatic Organisms and Pathogens transferred by ship ballast water. Reviewing papers concerning risks related to a ship’s Ballast Water and BW management.

Chapter 3 is the data collection by grouping information from the received survey. The discussions and comments present in every significant aspect.

Chapter 4 summarises the impact of the BWM Convention on seafarers.
Chapter 2 the Ballast Water Management Convention

This chapter reviews the background of the BWM convention which impacts on the maritime industry.

2.1 Introduction

Ballast water operations occur in the normal activities of a ship when engaged in cargo operations between ports. When uploading Ballast Water (BW), ships also pump in sediments and organic matter. Therefore, numerous organisms are introduced into ballast tanks and when discharged in new ecosystems it may cause problems.

The worldwide recognition of HAOP led to several efforts to tackle this issue. For instance, the United Nation Conference on Environment and Development (UNCED) adopted the Convention on Biological Diversity (CBD) (GEF et al., 2013).

IMO, a specialized agency of the UN developed MARPOL convention to deal with marine pollution, but discussions about ballast water issues were not included.

The Marine Environment Protection Committee (MEPC) supported the development of the BWM convention to deal with HAOP in BW.

In 2004, the IMO adopted the BWM convention to mitigate the risk of introducing HAOP in a recipient environment by requiring ships to manage BW according to the Convention’s standards. Thus, measures such as BW Exchange and installation of BWMS are presently recognized method to control the risk of introduction of HAOP. (Gollasch, S., & David, M., 2014).

2.2 Ballast Water Management Convention requirements

The BWM convention was adopted at an IMO conference on Ballast Water Management for ships in 2004. (Gollasch, S., & David, M., 2014).
However, the BWM convention entered into force on 8 September 2016 when Finland ratified the Convention. So, the BWM convention entered into force 12 months later, on 8 September 2017 (IMO, 2016b).

All ships have to comply with the convention and provide the following:

- International Ballast Water Management certificate (IBWM) that certifies by flag state or RO which flag state authorizes.
- Ballast Water Management Plan (BWMP) which is approved by flag state or RO which flag state authorizes.
- The method to mitigate the risk has two solutions by accepting due to BWM Convention (Ballast water exchange method D-1 or Ballast Water performance system D-2 or eventually D-4)

D-1 standard BWE is a temporary method. After 08 September 2024 (see Figure 1), all ships will have to comply with the D-2 standard. Ships will have to install BWMS to comply with the D-2 standard.

![Figure 1 Timeframe to comply with D-2 standard](Source: MAREX, 2017)
2.3 Risks related to Ballast water management methods

2.3.1 Ballast water exchange system

BWE is a method to change BW in the deep sea (the standards are defined in the Convention). However, there are several factors that influence the effectiveness of BWE.

1. Type of ship or ballast tank, especially size or shape
2. Types of organisms
3. Method of BWE
4. Geographic location
5. Environmental conditions, such as salinity
6. Voyage duration
7. Sampling and experimental design

(O'Sullivan, E. G., 2010)

The methods to conduct BWE, according to the guideline for ballast water EXCHANGE (G6) by IMO, are the following:

- Sequential method or Empty and refill method
- Flow-through method
- Dilution method (see Figure 2)

BWE may affect the safety of the ship and crew:

Ship factors:
1. Ship stability has to comply with the ship stability booklet all the time to keep the seaworthiness condition of the ship. This includes the draft, trim and propeller immersion, the condition of ship, an additional factor such as free surface effects, wave-induced hull vibrations.

2. The optimization of ship stress includes longitudinal stress, torsional stress, shear force and bending moment.

3. The balance between the capacity of a tank and vent to receive pressure from BWE conduct.

4. Flow rates of ballast water pump and maximum capacity of pump and piping.

5. Avoidance unnecessary discharge of ballast water

6. Safety consideration to choose the BWE method

Nature factors:

1. Limitations during heavy weather condition.

2. Admissible weather conditions to conduct BWE.

3. Routing weather forecast such as cyclones, typhoons, and heavy icing condition.

4. The BWE conduct should avoid freezing weather conditions, or in specific cases as the freezing of piping, vents, valves and air pipes.

5. Avoidance loading HAOP and sediments.

Crew factors:

1. Additional workload during ballast water operations.

2. Document records of ballast water operations.

3. Contingency plan and procedure in case unexpected events occurred such as pump failure and weather changing.

4. The BWE task includes time to operate of each tank, tank monitoring, line and pump pressures.

5. In some cases, personal safety may be affected when conducting such operations (e.g. night work in engine or Ballast room).
6. The training and education of ballast water operations include BWMP, BWRB, Safety Management System (SMS) procedure, familiarization with the ballast water system on-board, method for sounding and monitoring during BWE operations.

(IMO, 2005b), (Globallast, 2014-2017c).

2.3.2 Ballast water management system

The implementation of the BWM Convention forced the shipping industry to have a system to mitigate the risk of HAOP. Although the system for treating ballast water on-board has many brands, the same standard is based on the BWM convention regulation D-2.

Treating BW implies the use of specific equipment and eventually chemicals which may have negative impacts on people, the ship and the environment. For example, toxic components may remain in tanks. To avoid such detrimental impacts, the IMO Guidelines G8 and G9 require the BWMS to be constructed and tested appropriately.

The testing purpose of BWMS for ensuring treatment system does not become harmful to human, and the environment. (IMO, 2008).

Recently, regarding the list of final BWMS approved on November 2016, 41 systems were approved (IMO, 2016c).

On the other hand, the USCG has different standards to approve BWMS. Recently, six BWMSs have been approved by the USCG and one BWMS is under review (USCG, 2017).

In fact, most systems use pre-treatment (i.e. filtration). Treatment processes are categorized in three groups: Mechanical (filtration) and Physical and Chemical (Werschkun, B et al., 2014), (GEF et al., 2013).

Ballast water operation on-board can be divided into five tasks including starting BWMS, Ballasting, De-Ballasting, Cruising and maintenance. Each operation has its own risks for operators.
Seafarers should be aware of risks related to operations and the shipping company should be prepared for all possible protective measures for seafarers (Werschkun, B et al., 2014) (figure 3).

In conclusion, the impact of BWMS on seafarers is non-negligible. Seafarers need to consider the risk before reacting to specific exposure events. Seafarers should acquire sufficient knowledge to operate with BWMS because different types of treatment systems have different types of risks.

<table>
<thead>
<tr>
<th>Unit Operation</th>
<th>Work Activity</th>
<th>Exposure Scenario</th>
<th>Exposure Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starting of BWMS</td>
<td>type specific activities to be documented, e.g. calibration</td>
<td>type-specific</td>
<td>dermal, inhalation</td>
</tr>
<tr>
<td>Ballasting</td>
<td>ballasting</td>
<td>potential exposure to volatile substances from exhaust air</td>
<td>inhalation</td>
</tr>
<tr>
<td></td>
<td>treating of ballast water</td>
<td>type specific</td>
<td>dermal, inhalation</td>
</tr>
<tr>
<td></td>
<td>sampling</td>
<td>exposure to chemicals in treated ballast water</td>
<td>dermal, inhalation</td>
</tr>
<tr>
<td>De-ballasting</td>
<td>de-ballasting</td>
<td>potential exposure from spray drift</td>
<td>dermal, inhalation</td>
</tr>
<tr>
<td></td>
<td>treating of ballast water</td>
<td>type specific</td>
<td>dermal, inhalation</td>
</tr>
<tr>
<td></td>
<td>sampling</td>
<td>exposure to chemicals in treated ballast water</td>
<td>dermal, inhalation</td>
</tr>
<tr>
<td>Cruising</td>
<td>storage of treated ballast water</td>
<td>potential exposure to volatile substances from exhaust air</td>
<td>inhalation</td>
</tr>
<tr>
<td></td>
<td>sampling</td>
<td>exposure to chemicals in treated ballast water</td>
<td>dermal, inhalation</td>
</tr>
<tr>
<td>Maintenance</td>
<td>tank cleaning (sediment cleaning)</td>
<td>exposure to residual water, sediment and vapour of volatile substances in ballast tank</td>
<td>dermal, inhalation</td>
</tr>
<tr>
<td></td>
<td>tank inspection</td>
<td>exposure to vapour of volatile substances in ballast tank</td>
<td>inhalation</td>
</tr>
<tr>
<td></td>
<td>type specific: UV: change/cleaning of UV tubes ozone: filter change, electrode calibration chemical: resupply, cleaning of storage tanks electrolysis: washing of filter cartridges, electrode calibration</td>
<td>type-specific</td>
<td>dermal, inhalation</td>
</tr>
<tr>
<td>Malfunctions</td>
<td>any of the listed work activities or independent thereof</td>
<td>leakage, ventilation breakdown</td>
<td>dermal, inhalation</td>
</tr>
<tr>
<td>Accidents</td>
<td>any of the listed work activities</td>
<td>e.g. splashing of chemicals during resupply</td>
<td>dermal, inhalation</td>
</tr>
<tr>
<td>Emergencies</td>
<td>distress and salvage operations</td>
<td>e.g. explosion, fire</td>
<td>dermal, inhalation</td>
</tr>
</tbody>
</table>

Figure 3 Unit operations and associated work activities for BWMS
Source: Werschkun, B et al., 2014
2.4 Elements of the convention affecting seafarers

The implementation of the convention increases many tasks and workloads for seafarers. It also affect training and education.

The impact on seafarers from the BWM Convention can be described as follows.

2.4.1 Articles of the BWM Convention

This part of the convention states the general obligation of member states who have ratified the BWM Convention organizing 22 articles. The details of this part do not directly impact on the seafarer but apply to member states.

2.4.2 Annex, regulations for the control and management of ships’ ballast water and sediments

This part of the convention is organized in five sections. Stakeholders can be separated into three categories that are Seafarer, Shipowner and Member state (port state, flag state, coastal state).

<table>
<thead>
<tr>
<th>Regulation section</th>
<th>Involve seafarer</th>
<th>Involve Ship company</th>
<th>Involve member state</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section A – General provisions.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Section B Management and control requirements for ships</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Section C Special requirement in certain areas</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Section D Standards for ballast water management</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Section E Survey and certification requirements for ballast water management</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Table 1 Involving BWM Convention to main stakeholders.
Source: Author

According to table 1, this research will focus on seafarer part which is following.
Section B Management and control requirements for ships

Regulation B-1 Ballast Water Management Plan (BWMP)

The BWM Convention imposes BWMP approved by ROs or flag states. The details of BWMP include guideline, safety procedure, description of actions, procedures to operate BWM at sea and shore, sediment management, role and tasks of designated officer and operators as well as reporting and recording procedures.

This regulation impacts seafarers as follows

- Designated person of BWM should understand the details of BWMP and train seafarers.
- The seafarer should know the safe working practices on BW Operations following the BWMP and sediment removing at sea or shore.
- Seafarers should properly operate on reporting requirement due to the BWM Convention.

Regulation B-2 Ballast Water Record Book (BWRB)

The officer in charge of ballast water has a responsibility to record all ballast activity. BWRB can be in electronic or paper form which has to be signed by the Officer in charge and be kept on-board for two years. Another purpose of BWRB is to provide evidence of BW operations during Port State Control (PSC) and flag State survey.

This regulation impacts seafarers as follows

- The BWM officer should understand how to record in BWRB and train other officers.
- The BWM officer should prepare the Ballast Water Record Form (BWRF) prior to the arrival in port using the data available in BWRB.
- The BWM officer should maintain the BWRB and report commencement and completion of BWE as well as any BW operation even in case of D-2 BWMS installed onboard.
- The BWRB should be available during inspection.
- The recorder should be able to record all the details and exceptions on BWRB.
**Regulation B-4 Ballast Water Exchange (BWE)**

A ship conducting BWE should comply with B-4 requirements. Firstly, the position to conduct BWE should be far from the nearest land; 200 Nautical miles and at least 200 meters of water depth. Secondly, if the ship cannot meet the first standard, it should conduct BWE as far as possible but the distance shall not be less than 50 Nautical miles and at least 200 meters of water depth.

This requirement aims to reduce the risk of coastal organism to remain in Ballast tanks. The seafarer has to conduct BWE by cooperating between the deck and engine department, and plan well before starting every ship voyage. The passage planning process to conduct BWE should consider influencing factors including heavy weather, ship stability, emergency situation and density of ship traffic (IMO, 2017). The impact of this requirement on seafarers is as follows.

**This regulation impacts seafarers as follows**

- Seafarers should know how to conduct BWE operations following BWMP.
- Seafarers should be aware of risk and limitations on operations such as loss of stability.
- Seafarers have to monitor the process of exchanging the water which may take numerous hours.
- Safety operations as per the ISM code should be taken into account.

**Regulation B-5 Sediment Management for Ships**

The removing of sediment in ballast tanks reduces the risk of HAOP. An active organism can transform into different types in a life cycle such as cysts, eggs and other dormant and embedding in sediment (GloBallast, 2017). It requires sediment removal in compliance with BWMP (IMO, 2017). Sediment management requires tank entry which signifies that seafarers are exposed to numerous risks related to enclosed spaces and exposure to sediments that may contain toxic matter or HAOP.
This regulation impacts seafarers as follows

- Seafarers should have the knowledge on safety operations to conduct sediment removal.
- Safety procedures to enter enclosed spaces have to be known and applied (particularly pre-entry procedures and checklists).
- Sufficient personal protective equipment and atmosphere monitoring devices should be prepared for seafarers.

Regulation B-6 Duties of officer and crew

Seafarers should know the system and function of ballast management on their ship. Especially, seafarers working on BWMS should be familiar with the technology and system for the safe operation of the ship and life itself.

This regulation impacts seafarers as follows

- Seafarers should be familiar with BWMP, BWE, and BWMS duties in BW operations.
- BWM officers should train crews onboard for to familiarize BWM operations and risks on operations.

Section C Special requirements in certain areas

BWM in each State has a different issue and sensitive factor which shall be taken into account. Section C of the Convention gives the authority to regulate the additional measure beyond the minimum requirements by member states. According to guidelines for additional measures regarding ballast water management, including emergency situations (G13), the State can set additional measures based on an event such as scientific, assuagement or risk which has a potential to harm their own water.
Section D Standards for ballast water management

Regulation D-1 Ballast Water Exchange standard

Each ship may be fit for different methods depending on the design of the ship, type of ship and the limitations of the ship’s stability. The BWE standard is a temporary solution of the BWM Convention. However, the requirements set the same standard for ship have to achieve which is following.

- The method to exchange BW has to meet the standards of exchanging water with 95% of the water exchange volume.
- The BWE flow-through method should meet 3 times of tank capacity or comply with 95% of the exchange volume.

Addition from B-4 regulation, this regulation impacts seafarers as follows.

- The BWM officer should know the limitations of this regulation and train seafarers.
- Seafarers have to conduct the operation in compliance with BWMP and record each operation in BWRB.
- The BWE operations may require extra personnel to operate the BWE.
- Workload and fatigue from BWE operation.
Regulation D-2 Ballast Water Performance standard

This regulation affects seafarers in any dimensions. Because BWMS require specialized knowledge to operate and it has more risks in operation to the seafarer.

This regulation impacts seafarers as follows

- Seafarers should be familiar with BWMS and their duties during BW operations.
- Operations and recording have to be conducted according to BWMP.
- The BWM officer should train the crew onboard to familiarize the BWM operations and risks of operation.
- Risks on operations with BWMS such as the exposure to/from chemicals.
- The BWMS requires maintenance on BWMS and the equipment by seafarer.
- Special Healthcare precautions and medical check to reduce the risk of the operation.

Section E Survey and certification requirements for ballast water management

The ship survey may be separated into two groups, which are the normal survey and unusual survey.

The Normal survey includes: Initial survey; Renewal survey (after max. 5 years); Intermediate survey, and Annual survey.

Additional survey may be undertaken when a ship has a significant change or repair relating to the convention.

Surveys and inspections may identify non-conformities which demand corrective action by seafarers. In case of major non-conformity, the ship may be detained (Globalballast, 2014-2017c).
2.5 Ballast water operation planning and on-board duty

BW planning is a process to ensure that ship operations on BW are sufficient in complying with the regulations and requirements due to the BWM Convention. Moreover, any operation requires planning in order to ensure the weight distribution will not affect the safety of the ship and the BWM practice will be performed according to the standards.

2.5.1 Ballast water operation planning

The planning process is a mandatory step to prepare the ship to comply with the BWM convention. Adequate planning facilitates safe operations onboard and reduces the uncertainties related to BW operations.

The planning step should cover aspects as follows

- Checking ROB (remaining on board) of Fuel, Diesel and Lub. Oil and quantities of freshwater and the remaining BW of each tank
- The tank sequence plan is based on the calculations and simulations of BW operations as per the BWMP requirements. The purpose is to assess ship stability including draft and trim and ship stresses during BW operations.
- Work and rest periods of seafarers should be taken into account.

This regulation impacts seafarers as follows

**Preparation**

- Seafarers should be conversant with the equipment and able to conduct BWM operations following BWMP.
- Seafarers should have knowledge of the basic requirement of the BWM Convention.
- Seafarers should operate the BWM based on safety working practice.

**Conduct**

- Seafarers should be able to respond to the inspector and correct any action due to the ship’s defect.
- Seafarers should operate BWM when needed.
• Take into account port state and terminal condition of arrival port.
• Check pump and pipe and air vent condition.
• The special requirement of each country should be taken into account.

Moreover, planning should distribute the responsibility of the BWM team as follows

• The officer in charge supported by the ship master should plan and consider every factor affecting BWM such as alga blooming areas and warnings.
• The Chief Officer (as officers in charge) should focus on ship stability during the BW operation and report to the Ship master if finding any difficulties. The designated person should operate BWM as per BWMP and keep records of every BW activity into BWRB. He/she must be available to advise the crew members participating in a BWM.
• The Deck officer should be familiar with BWMP and BW operations. Such officers should operate according to BWMP and the special requirements of the BW designated person.
• The Chief Engineer should cooperate with the Master in the technical aspects of BWM operations and must train crew members to be familiar with the BWM equipment on-board.
• The Engineer Officer should follow the Chief Engineer’s plan by checking the technical conditions of the BWM equipment and performance of BWMS. They must have the knowledge on the piping and BWT on-board and should provide ROB information.

The Planning process can include many solutions to handle the BWM during a ship’s voyage. According to Best Practice and Planning for Managing Ballast Water, the BWM control option during ship voyage can be divided into three stages (see Figure 4).
In addition, different BWM methods have to concern more factors as follows.

2.5.1.1. Planning for BWE (D-1)

The BWE plan should include many factors such as geographic restrictions during ship transit. Indeed, the BWE has to consider the BWM Convention demands in terms of distance from the shore; 200 Nautical miles and 200 water depth. In addition, the weather conditions have to be considered as well as the availability and equipment capacities.

2.5.1.2. Planning with the BWM System (D-2)

Planning should take into account the following.

- Checking the conditions and functions of BWMS is available in a good performance
- Checking the power supply and generator
- Checking the lubricant oil and other levels such as chemicals
- Familiarize seafarers with the instructions and risks of BWMS operations

2.5.2 On-board Ballast Water Management

BWM operations impact both the deck and engine departments. Moreover, for safe BW operations, seafarers can use a checklist, which should be provided in BWMP, to help during BW operations (Globalballast, 2014-2017c).
Follow the plan of action determined during the planning phase

Complete the pre-BWM checklist

Activate the equipment as required (BW Pumps, valves, BWMS if available)

Control the well-functioning of equipment / round to verify leakage or other issue

Monitor filling/emptying of BWT – verify with sounding individual tanks if no remote sensors

Ensure completion of activities by verifying no errors or mistakes during the process – verify levels of tanks according to plan

Re-check calculation of strength and stability throughout the process

Report any defect to the engine department

Record position/time/quantity and any other relevant information in the BWRB

2.6 Training and education relating to the Ballast Water Management convention

According to the BWM Convention regulation B-6, seafarers shall be familiar with ballast water operations including BWMP, BWRB, and the method to conduct ballast water operations (IMO, 2009).

The Shipowner/operator/company (as identified under ISM Code) has the responsibility to support training and education for seafarers including ballast water operation and sediment removal and the related risks (IMO, 2005a).

For appropriate training and education, ballast water management training should cover the following topics.

1. The Regulations of the BWM Convention.
2. Guidelines to comply with the BWM Convention.
3. BWMP development implementation and operation.
4. Ballast water management and safety procedures.
5. BWE safety procedures.
6. Ballast water management techniques and methodologies.
7. Operation and maintenance of ballast water treatment technology and system.
8. National and regional requirements.
9. How to record and keep BWRB.
10. Safety operation on sediment control and its removal.
11. Handing, storage and preparation of chemical active substances more detail in BWM.2/Circ.20

(IMO, 2017)

BW Operations involve many risks which require the knowledge from seafarers. To reduce the risks in operations and human error and improve safety training, education is important.
Chapter 3 Data collection

This dissertation uses qualitative and quantitative analysis to code the data. The process to do qualitative and quantitative analysis started by collecting data which has information from the seafarer participants. The Participants are separated into 2 groups: seafarers following D-1 standard (BWE) and those following D-2 standards (BWMS).

This chapter follows the organization of the questionnaire provided to each group of seafarers.

As the first part of the questionnaire intends to assess the demographic and experience of seafarers, the response from D-1 and D-2 questionnaires are together (Q1 to Q6).

The first set of answers corresponds to seafarers using D-1 and second set to D-2.

3.1 Demographic of the panel of seafarers and experience related to BW operation

Part1 General Information

Q1. Age of participant seafarers?
The analysis of age will divide into five ranges from 20 years to 60 years from twenty-five participants.
### Table 2: Age of participant seafarers.
*Source: Author*

<table>
<thead>
<tr>
<th>Range of age</th>
<th>Number of participant (Persons)</th>
<th>Percentage from total participant</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 – 29 years</td>
<td>2</td>
<td>8.00%</td>
</tr>
<tr>
<td>30 – 39 years</td>
<td>20</td>
<td>80.00%</td>
</tr>
<tr>
<td>40 – 49 years</td>
<td>2</td>
<td>8.00%</td>
</tr>
<tr>
<td>50 – 59 years</td>
<td>1</td>
<td>4.00%</td>
</tr>
<tr>
<td><strong>Total of participant</strong></td>
<td><strong>25</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

**Comment:** This suggests that most participants are experienced and probably in mid-term careers.

### Q2. Which region are you from?

The analysis of regions was separated into nine regions around the world as follows.

### Table 3: Region of participant seafarers.
*Source: Author*

<table>
<thead>
<tr>
<th>Region of seafarers</th>
<th>Number of participant (Persons)</th>
<th>Percentage from total participant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Central America</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>Middle East</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>South America</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Asia</td>
<td>23</td>
<td>92%</td>
</tr>
<tr>
<td>Caribbean</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>North America</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Europe</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>Oceania</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Total of participants</strong></td>
<td><strong>25</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>
Comment: According to table 3, Asian dominated the panel (92%). This distribution represents the presence of seafarers at WMU and the network of the author. However, the overrepresentation of Asian seafarers should not impact the study as most ships are similar and work onboard having a lot of commonalities due to the development of the ISM Code and companies hiring multicultural crews.

Q3. Certificate of competency (COC)?
This part of the data from twenty-five participants categorized by class due to the COC of an officer on-board.

<table>
<thead>
<tr>
<th>Holding COC</th>
<th>Number of participants (Persons)</th>
<th>Percentage from total participants</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deck department</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Master mariner international voyage</td>
<td>8</td>
<td>32%</td>
</tr>
<tr>
<td>Chief officer</td>
<td>5</td>
<td>20%</td>
</tr>
<tr>
<td>Deck officer</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td><strong>Engine department</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chief engineer</td>
<td>7</td>
<td>28%</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt; engineer officer</td>
<td>4</td>
<td>16%</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt; engineer officer</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Total of participant</strong></td>
<td>25</td>
<td>100%</td>
</tr>
</tbody>
</table>

*Table 4 Certificate of competency (COC) of participant seafarers.*
*Source: Author*

Comment: In short, the respondents overwhelmingly hold senior officer certificates. Therefore, it is suggested that they are conversant with ballast water management.
Q4. Last position on-board?
In grouping the data of the last position on-board categorises the rank of the seafarer from previous experiences on-board. Twenty-five participant seafarers, including the deck and engine department, will be categorised due to the rank of last position as follows.

<table>
<thead>
<tr>
<th>Last position on-board</th>
<th>Number of participants (Persons)</th>
<th>Percentage from total participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deck department</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Master mariner</td>
<td>6</td>
<td>24%</td>
</tr>
<tr>
<td>Chief officer</td>
<td>6</td>
<td>24%</td>
</tr>
<tr>
<td>Deck officer</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>Engine department</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chief engineer</td>
<td>5</td>
<td>20%</td>
</tr>
<tr>
<td>2nd engineer officer</td>
<td>4</td>
<td>16%</td>
</tr>
<tr>
<td>3rd engineer officer</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>Total of participant</td>
<td>25</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 5 Last position of participant seafarers.
Source: Author

Comment: According to table 5, the distribution shows that the panel of seafarers emphasises mostly senior officers experienced in ballast water management.

Q5. Experience in last position?
This part categorises the data of twenty-five seafarers into three groups that are 1-3 years, 4-6 years, and 7-9 years.

<table>
<thead>
<tr>
<th>Experience in last position</th>
<th>Number of participants (Persons)</th>
<th>Percentage from total participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3 years</td>
<td>20</td>
<td>80%</td>
</tr>
<tr>
<td>4-6 years</td>
<td>3</td>
<td>12%</td>
</tr>
<tr>
<td>7-9 years</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>Total of participants</td>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>

Table 6 Experience in last position of participant seafarers.
Source: Author
Comment: According to table 6, most seafarers in the panel have limited experience in their ranks.
It is suggested that most participants are newly promoted senior staff.

Q6. Total seafarer experience?
This part divides the total seafaring experience of participants into 6 groups as follows.

<table>
<thead>
<tr>
<th>Range of experience (years)</th>
<th>Number of participants (Persons)</th>
<th>Percentage from total participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 5 years</td>
<td>6</td>
<td>24%</td>
</tr>
<tr>
<td>6 – 10 years</td>
<td>14</td>
<td>56%</td>
</tr>
<tr>
<td>11 – 15 years</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>16 – 20 years</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>21 – 25 years</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>25 – 30 years</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>Total of participant</td>
<td>25</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 7 Total seafarer experience of participant seafarers.
Source: Author

Comment: According to table 7, more than 2/3 of the respondents are experienced seafarers with more than 6 years at sea.
Therefore, it is suggested that they have experience in ballast water operations.

Conclusion of Part 1 – despite the small size of the panel (25), the seafarers who responded are relevant for the study because they are experienced.
3.2 Answers related to D-1 Ballast Water Exchange group

Part 2 Ballast water operation and maintenance
In this part the information is organized in two main topics that are familiarity with the BWM Convention and the requirement method and maintenance method of the ballast water operation system.

Part familiarity with BWM Convention including:

Q7 Are you familiar with the Ballast Water Management Plan?
The answer from twenty seafarers about familiarity with BWMP and the procedure as follows.

![Pie chart showing familiarity with Ballast Water Management Plan](Source: Author)

| Yes, 18, 90% | No, 2, 10% |

Comment: It suggests that most seafarers are familiar with BWMP.

Q8 Are you familiar with the Ballast Water Record book?
The answer from twenty seafarers about familiarity with BWRB and the procedure as follows.
Part of ballast water operation and maintenance method.

Q9 Have you been engaged in Ballast Water operations?
The answer from twenty seafarers about engaging in BW operations is as follows.

A result of 19 participants answered concerning the role of engaging in ballast water operations, which can categories the answer into 3 groups as follows.

<table>
<thead>
<tr>
<th>No.</th>
<th>How to engage in ballast water operation</th>
<th>Number (persons)</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Over command, recheck plan and approve</td>
<td>3</td>
<td>16%</td>
</tr>
<tr>
<td>2</td>
<td>Command and control operation</td>
<td>11</td>
<td>58%</td>
</tr>
<tr>
<td>3</td>
<td>Supporting operation</td>
<td>5</td>
<td>26%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>19</td>
<td></td>
</tr>
</tbody>
</table>

Table 8 Role to engage in ballast water operation of participant seafarers. Source: Author

Comment: It suggests that most seafarers are familiar with BWRB due to the convention.
Q10 Have you been the officer in charge of Ballast Water Management?
This question asks about the experience of a seafarer’s responsibility in charge of BWM. Usually, this responsibility will be designated to the Chief Officer who carries out ballast water operations.

![Figure 8: Designated to be the officer in charge of Ballast Water Management.](Source: Author)

A result of 11 participants has been designated in charge of BWM. They have a period of experience which can be categorized into 3 ranges as following.

<table>
<thead>
<tr>
<th>Range of officer in charge experience (years)</th>
<th>Number of participants (Persons)</th>
<th>Percentage from total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 2 years</td>
<td>7</td>
<td>64%</td>
</tr>
<tr>
<td>3 – 4 years</td>
<td>3</td>
<td>27%</td>
</tr>
<tr>
<td>5 – 6 years</td>
<td>1</td>
<td>9%</td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>

*Table 9: Experience of participant seafarer on officer in charge of ballast water*

*Source: Author*

Comment: It suggests that most seafarers has been engaged in BWM operation which has different task onboard.
Responses from Q7 to Q10 confirm that the panel is conversant with BW Operations and a majority of them have directly been in charge of such operations.

Q11 What kind of ballast exchange method which you use?

The answers from participants can be categorized into three parts due to the IMO recommended method. One person can answer more than one method. Moreover, the participants can give an opinion supporting the BWE method as follows.

<table>
<thead>
<tr>
<th>BWE method</th>
<th>Number of participants (Persons)</th>
<th>Percentage from total</th>
<th>A reason support decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sequential (Empty/refill)</td>
<td>17</td>
<td>59%</td>
<td>1. Fit for long voyage to maintain stress and stability of vessel</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. High efficiency and effective to clean a tank</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. Sequential easier to control and more effective to clean a tank.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4. Less likelihood to occur problem to cargo</td>
</tr>
<tr>
<td>Flow through</td>
<td>12</td>
<td>41%</td>
<td>1. This method is the most suitable for container ship because it can let water overflow,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>but have to clean deck by fresh water again.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. On tanker vessel, flow through is the most suitable.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. It is the easy method to conduct BWE without serious monitoring operation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4. In case of heavy weather flow through is the best operation.</td>
</tr>
<tr>
<td>Dilution</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 10 BWE method used by participants.

Source: Author

Comment: It suggests that all Chief Officers and Ship Masters have been designated in this responsibility.

This distribution represents the experience of seafarers at the Chief Officer rank which takes responsibility for the BWM.
**Q12 How did you maintain and repair the Ballast Water Management system?**

An open question providing the possibility of a respondent to comment. The comments are summarized in the last column of the table.

<table>
<thead>
<tr>
<th>Maintenance method</th>
<th>Number of participants (Persons)</th>
<th>Percentage from total</th>
<th>Detail of maintenance</th>
</tr>
</thead>
</table>
| On-board                 | 20                               | 80%                    | 1. Follow PMS check tank every 6 months  
2. Pipe line, pump and valve inspection and repair  
3. Check pump capacity and flow rate and cooperate with engineer, check vent and air pipe monthly |
| By company               | 1                                | 4%                     | 1. By inspection and repair by specialize personal during dry dock                   |
| By outsource service     | 4                                | 16%                    | 1. Ship repair and maintenance involving ballast pump and piping  
2. Repairing remote control ballast Valve  
3. Maintenance in dry dock       |
| Total                    | 25                               |                        |                                                                                      |

*Table 11 Maintenance and repair Ballast Water Management equipment*

*Source: Author*

**Comment:** According to table 11, it suggests that most of maintenance and repair remain on seafarers’ shoulders. D-1 implies multiplication of BW operations (upload/exchange/discharge) therefore, the workload related to repair and maintenance may increase.

**Comment:** It suggests that significantly supporting the reason to use sequential is that this method usually is possible on all ships while flow-through and dilution require specific piping systems.
Part 3 Training and education

Interview question can be separated into five questions covering all of the training topics. By answer separate into five choices and require for detailing of training method.

In case of participants who answer more than one choice, a score is accounted for the lower answer of training source. For example, if participant answer Self-learning and By Company, the score is accounted in By Company.

Q13 Have you been trained on Ballast Water Management Plan and procedure, and How?

![Figure 9 Participants of training in Ballast Water Management plan and procedure. Source: Author](image)

<table>
<thead>
<tr>
<th>Training method</th>
<th>Number of participants (Persons)</th>
<th>Percentage from total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-learning</td>
<td>2</td>
<td>10%</td>
</tr>
<tr>
<td>On-board</td>
<td>6</td>
<td>30%</td>
</tr>
<tr>
<td>By company</td>
<td>10</td>
<td>50%</td>
</tr>
<tr>
<td>By outsource</td>
<td>2</td>
<td>10%</td>
</tr>
<tr>
<td>Other</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total participants</strong></td>
<td><strong>20</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

*Table 12 Training in Ballast Water Management Plan and procedure. Source: Author*

**Comment:** It suggests that shipping companies do not sufficiently support training and education for all seafarers on BWMP.
Q14 Have you been trained on Ballast Water Record Book, and How?

<table>
<thead>
<tr>
<th>Training method</th>
<th>Number of participants (Persons)</th>
<th>Percentage from total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self- learning</td>
<td>3</td>
<td>15%</td>
</tr>
<tr>
<td>On-board</td>
<td>3</td>
<td>15%</td>
</tr>
<tr>
<td>By company</td>
<td>8</td>
<td>40%</td>
</tr>
<tr>
<td>By outsource</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Other</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total participants</td>
<td>20</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 13 Training in Ballast Water Record Book.
Source: Author

Comment: It suggests that shipping companies should develop training and education on BWRB to seafarers.

Q15 Do you know the basic requirement of the Ballast Water Management Convention?

Answers from twenty seafarers about knowledge and understanding on basic requirement of BWM Convention is following.
Training method | Number of participants (Persons) | Percentage from total
--- | --- | ---
Self-learning | 6 | 30%
On-board | 4 | 20%
By company | 7 | 35%
By outsource | 1 | 5%
Other | - | -
Total participants | 20 | 100%

Table 14 Knowledge on basic requirement of Ballast Water Management Convention.

Source: Author

**Comment:** It suggests that shipping companies do not support enough training and education on the basic requirement of the BWM Convention for seafarers.

**Q16 Have you been trained on other topic related to Ballast Water Management, and How?**

Answers from twenty seafarers about training on other topics related to BW management is following.
Table 15 Training in other topics related to Ballast Water Management
Source: Author

<table>
<thead>
<tr>
<th>Training method</th>
<th>Number of participants (Persons)</th>
<th>Percentage from total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-learning</td>
<td>4</td>
<td>20%</td>
</tr>
<tr>
<td>On-board</td>
<td>4</td>
<td>20%</td>
</tr>
<tr>
<td>By company</td>
<td>10</td>
<td>50%</td>
</tr>
<tr>
<td>By outsource</td>
<td>1</td>
<td>5%</td>
</tr>
<tr>
<td>Other</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total participants</strong></td>
<td><strong>20</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

**Comment:** It suggests that seafarers need additional education and training from shipping company on relevant topics of BWM such as technique and theory of BWM and operation.

### Part 4 Impact on work
This part interview question relating to impact, and issue on ballast water management operation. By separating question cover the scope of the issue into six questions. Answers are description issue and opinion from experience of seafarers.

**Q17 Does new regulation on Ballast Water Management affect your workload?**
A result of 14 participants agree with BWM regulation effect on workload can categories the answer into five groups. Among the comments provided by respondents, 12 are directly related to workload; the two other answers were not related to the workload of seafarers but to difficulties in applying standards on short- sea shipping. Considering that the survey does not distinguish by department, it is clear that seafarers not directly engaged on BW operation or maintenance are not affected.

<table>
<thead>
<tr>
<th>BWM regulation effect on work</th>
<th>Number (persons)</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. More maintenance of BWM equipment</td>
<td>2</td>
<td>17%</td>
</tr>
<tr>
<td>2. Additional work due to BWE</td>
<td>7</td>
<td>58%</td>
</tr>
<tr>
<td>3. More paper work due to regulation</td>
<td>3</td>
<td>25%</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 16 How does BWM convention affect to seafarer work load
Source: Author

**Comment:** It suggests that new regulations significantly impact on seafarers by increasing workload such as operation and paperwork which requires additional workers.

Q18 Do you have difficulties in complying with the Ballast Water Management Convention and Ballast Water Management Plan?

Figure 14 Difficulties in complying with the Ballast Water Management Convention and Ballast Water Management Plan
Source: Author
A result of 12 participants comments on the difficulties to apply the convention on board. Among the answers, two answers do not relate directly to the question: one related to D-2 standard preparation and another one to costs for the company.

<table>
<thead>
<tr>
<th>No.</th>
<th>Difficult to comply with BWM Con.</th>
<th>Number (persons)</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Restrict BWE in heavy weather and the short voyage</td>
<td>5</td>
<td>50%</td>
</tr>
<tr>
<td>2</td>
<td>Need frequent operation and long period for familiarizing</td>
<td>1</td>
<td>10%</td>
</tr>
<tr>
<td>3</td>
<td>Equipment to operate malfunction</td>
<td>1</td>
<td>20%</td>
</tr>
<tr>
<td>4</td>
<td>Voyage and commercial pressure</td>
<td>1</td>
<td>50%</td>
</tr>
<tr>
<td>5</td>
<td>Insufficient time/ Man for Ballast water operation.</td>
<td>2</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>10</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Table 17 How does BWM convention difficult to comply*

**Source:** Author

**Comment:** It suggests that BWE operation is restricted by heavy weather condition for safe working practice on the ship. Moreover, BWM operation is also limited by workload and unbalancing work and rest period on seafarers.

Q19 Do you have any limitation in Ballast water operation such as weather condition, ship stability, ship safety navigation, ship stress, geographic, distance, route, equipment such as flow rate etc.?

Most of the participants provided more than one comment. However, the comments can be classified into 9 topics.
<table>
<thead>
<tr>
<th>No.</th>
<th>Limitation topic</th>
<th>Number of participants (Persons)</th>
<th>Percent</th>
<th>A reason for the limitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Weather</td>
<td>11</td>
<td>27%</td>
<td>1. Weather condition in the rough sea, according to the code of safe working practice, limited operation. 2. Heavy water when the ship has much rolling, a suction pump will have the high presser and broken. 3. Weather effect sounding ballast tanks are not accurate</td>
</tr>
<tr>
<td>2</td>
<td>Ship stability &amp; Ship stress</td>
<td>7</td>
<td>17%</td>
<td>1. Ballast water changes ship stability and Center of gravity of ship. 2. Difficult to handle ship stability in bad weather condition. 3. Ship stability from cargo tank effect restrict BWE operation 4. High risk to loss ship stress in rough sea</td>
</tr>
<tr>
<td>3</td>
<td>Geographic</td>
<td>4</td>
<td>10%</td>
<td>1. Restrict operation in shallow water by BWE making much sediment. 2. If voyage close to land also limit due to the convention</td>
</tr>
<tr>
<td>4</td>
<td>Route and voyage</td>
<td>8</td>
<td>20%</td>
<td>1. Short voyage and time restrict to conduct BWE where closed to land.</td>
</tr>
<tr>
<td>5</td>
<td>Commercial agreement</td>
<td>1</td>
<td>2%</td>
<td>1. Shortest passage of the ship does not comply with regulation but charterer agreement to accept time frame for complying it.</td>
</tr>
<tr>
<td>6</td>
<td>Equipment issue, flow-rate and pump capacity</td>
<td>6</td>
<td>15%</td>
<td>1. Increase maintenance suction filter. 2. Flow rate pump in old ship reducing capacity 3. De-ballast when light ship condition, in some cases can make an airlock in seawater line and pump 4. Pump capacity does not seem sufficient to restrict time 5. Flow rate it makes difficult in some tank take a long time and delay ballast operation.</td>
</tr>
<tr>
<td>7</td>
<td>Ship design and structure</td>
<td>2</td>
<td>5%</td>
<td>1. Ship design and ship age may difficult to install treatment unit. 2. In old ship, structure does not design to have a sampling point of ballast water</td>
</tr>
<tr>
<td>8</td>
<td>Work and rest period, work load</td>
<td>1</td>
<td>2%</td>
<td>1. BWE operation will do only day time to comply with work and rest period</td>
</tr>
<tr>
<td>9</td>
<td>Operation issue</td>
<td>1</td>
<td>2%</td>
<td>1. Difficult continue monitoring the operation</td>
</tr>
<tr>
<td>Total participants</td>
<td>41</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Table 18 How are limitations of Ballast water operation. Source: Author |
**Q20 Have you experienced a problem in applying D-1( Ballast Water Exchange)?**

![Figure 16 Experience problem in applying D-1 standard](source: Author)

A result of 12 participants answered about what was a problem in applying the D-1 standard which can categories the answer into 4 groups as follows.

<table>
<thead>
<tr>
<th>No.</th>
<th>The problem to comply D-1</th>
<th>Number (persons)</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Nature</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Weather condition restrict BW operation</td>
<td>2</td>
<td>17%</td>
</tr>
<tr>
<td>2</td>
<td>Stop BWE because of finding alga bloom during operation.</td>
<td>1</td>
<td>8%</td>
</tr>
<tr>
<td></td>
<td><strong>Ship stability</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Ship list problem during exchange ballast water.</td>
<td>1</td>
<td>8%</td>
</tr>
<tr>
<td></td>
<td><strong>Ship voyage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Depth and distance non-comply with regulation, the ship had</td>
<td>1</td>
<td>8%</td>
</tr>
<tr>
<td></td>
<td>to deviate from normal passage.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Time restrict have to report charter and ship-owner for</td>
<td>1</td>
<td>8%</td>
</tr>
<tr>
<td></td>
<td>extension</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>The short voyage cannot complete operation</td>
<td>3</td>
<td>25%</td>
</tr>
</tbody>
</table>

**Comment:** It suggests that seafarers have several limitations in BW operation. By, weather condition is the significant impact on operation. Moreover, the shipping route also limits BWM operation by complying with regulation (distant 200Nms and 200M water depth).
<table>
<thead>
<tr>
<th>No.</th>
<th>The problem to comply D-1</th>
<th>Number (persons)</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Pump performance cannot make completely empty tank</td>
<td>2</td>
<td>17%</td>
</tr>
<tr>
<td>8</td>
<td>Flow-through method if ballast vent leak, it may damage to cargo.</td>
<td>1</td>
<td>8%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>12</strong></td>
<td><strong>100 %</strong></td>
</tr>
</tbody>
</table>

*Table 19 Problem to comply D-1 standard
Source: Author*

**Comment:** It suggests that conducting BWE in also voyages may be a challenge. Moreover, nature problem such as plankton bloom and equipment issue should be taken into account by seafarers before conduct BWE. Thus, seafarers need more knowledge in relating aspect to apply with the convention.

Q21 *Do you think Ballast Water Management operation may be dangerous?*

![Pie chart showing the responses to Q21](image)

Among the comments provided by respondents, six are directly related to being dangerous of BWM, the three other answers were not related to be dangerous of BWM but to comply with D-2 standards.
<table>
<thead>
<tr>
<th>No.</th>
<th>Comment on BW operation be dangerous</th>
<th>Number (persons)</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>The danger to ship stress and ship stability during a voyage, in case piping line connection broken in some area may cause of wrong ballast tank pumping.</td>
<td>1</td>
<td>17%</td>
</tr>
<tr>
<td>2</td>
<td>Non-comply with BWMP may effect to ship stress hogging sagging</td>
<td>1</td>
<td>17%</td>
</tr>
<tr>
<td>3</td>
<td>For the empty refill, method have ship stress, stability issue, and free surface effect, flow through you can have reduced visibility of ship navigation</td>
<td>1</td>
<td>17%</td>
</tr>
<tr>
<td>Tank inspection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Dangerous in case ballast tank inspection may have an accident such as somebody switches on BW pump.</td>
<td>1</td>
<td>17%</td>
</tr>
<tr>
<td>Equipment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>When ballast operation hurry that the pressure or vacuum has to build up fast and dangerous to the tanks and pipeline.</td>
<td>1</td>
<td>17%</td>
</tr>
<tr>
<td>Weather</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Dangerous when affecting from weather condition</td>
<td>1</td>
<td>17%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

*Table 20 Comment on BW operation be dangerous
Source: Author*

**Comment:** According to table 20, 51 % of the participant has the opinion on BWM be dangerous to ship stability aspect.

It suggests that BWE operation have to operate following BWMP and procedure, also require high knowledge of BWM officer to maintain ship stability.
Q22 Have you been inspected on Ballast Water requirements (Flag state, Port state, Classification)?

An opinion of 16 seafarers can categories into 4 type of inspection as follows.

<table>
<thead>
<tr>
<th>No.</th>
<th>Inspection source</th>
<th>Number of participants (person)</th>
<th>Percent</th>
<th>Detail of inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Flag state</td>
<td>1</td>
<td>6%</td>
<td>1. Inspected tank condition, record book, certificate</td>
</tr>
<tr>
<td>2</td>
<td>Port State Control</td>
<td>8</td>
<td>50%</td>
<td>1. PSC Australia checks BWRB about the position to conduct BWE. 2. Inspection BWMP and BWRB by PSC USA, India. 3. PSC in black sea region sampling water 4. Australia AMSA and coastguard and PSC 5. USCG port state checked ship position to exchange water and check seawater condition, time match with pump capacity.</td>
</tr>
<tr>
<td>3</td>
<td>Classification</td>
<td>3</td>
<td>19%</td>
<td>1. Inspection when ship docking by visual inspection piping line and ballast tank gaging.</td>
</tr>
<tr>
<td>4</td>
<td>Other inspection</td>
<td>4</td>
<td>25%</td>
<td>1. SIRE inspection every six months</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 21 Source of ship inspection
Source: Author

**Comment**: It suggests that seafarers have to receive many inspections from the public source such as PSC, coast guard and private sources such as classification and SIRE.
Part 5 Sediment operation/ Tank inspection
Part of sediment removing and ballast tank inspection that involves in ballast water management due to BWM Convention.

Q23 Have you ever been engaged in sediments removing?

Yes, 11, 55%
No, 9, 45%

Figure 19 Engaging in sediments removal
Source: Author

<table>
<thead>
<tr>
<th>No.</th>
<th>Sediment removing method</th>
<th>Number of participants (persons)</th>
<th>Percent</th>
<th>Detail of sediment removing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dry dock</td>
<td>8</td>
<td>73%</td>
<td>-</td>
</tr>
</tbody>
</table>
| 2   | On-board                 | 3                               | 27%     | 1. Flushing the tank for removing  
2. Removing sediment by handing on board at sea 
3. During voyage by opening man hole and doing enclose space procedure, then remove the sediment for doing tank inspection |
|     | Total                    | 11                              | 100%    |                             |

Table 22 Method for removing sediment
Source: Author

Comment: It seems to indicate that most of sediment removal operation may be conducted by dry dock service for tank inspection.
Q24 Have you ever been engaged in tank inspection?

![Figure 20 Engaging in tank inspection](source: Author)

Tank inspection procedures are in SMS of every shipping company. Thus, the answer of participants have similarities

1. Ballast tank inspected every six months on half numbers of total tank and covered all of the tanks in one year.

2. Inspect amount of sediment, tank condition sounding pipe air pipe, coating condition, tank ventilation, and Zink anode. Using fully PPE such as a personal gas detector, helmed, fire prove lamp, VHF and complying with enclose space permit with one person stand-by and mechanical ventilation all time.

The enclosed space entry did not comply in company safety procedure, or the crew did not know much on this matter. The operation ventilates the tanks by doing positive pressurize, freeing of toxic gas and measuring oxygen. By the company provide a minimum of the PPE, but it is not enough for all worker.

**Comment:** It suggest that tank inspection is an enclosed space operation which has to follow company procedure. However, in low standard or small shipping company may not sufficiently support PPE and equipment to operate in enclosed space (one C/E in the panel).
Part 6 Others opinion

Q25 Do you have any comment on the impact of Ballast water management on seafarers workload?

In this part is the open-end answer for participants giving the opinion about the impact of Ballast water management on seafarers workload. Form twenty seafarers have 18 additional comments which can summary significant idea as follows

- The quantity of impact on seafarers depends on ship type
- Port of call of the ship in deep seaport can reduce sediment accumulation in BWT.
- BW operation impact on deck department more than engine department
- Seafarers have the willingness to comply with the convention, but the shipping company has to support investment.
- Currently, the D-2 extension makes shipping company avoidance to comply and investment in BWMS.

The conclusion of responses related to D-1:

- Training and education: most seafarers have sufficient knowledge of their tasks. However, shipping companies should support training on seafarers, which covers all of the aspect relating to BWM.
- Difficulties: BW transfer is a regular task of seafarers, but BWE is an additional task of BWM. Most of the seafarers give the opinion about difficulties to comply with BWE standard in heavy weather condition.
- Problem: Most of the participant found problems to comply with BWE standard in short voyage ship because the condition of geography and period to conduct BWE are not enough to complete operation under the regulation.
- Technical issues: To conduct BWE, seafarers should take into account the condition of the ship and other factors. Each BWE method has a different restriction; seafarer should concern with the capacity of ship and machinery.
3.3 Answers related to D-2 Ballast water performance

This standard is a permanent ballast water management method instead of BWE. While, the effect from BWM Convention to shipping that has to invest in BWMS, IMO has a meeting to the extension the D-2 standard latest in 2024. This extension causes most of the ships still use BWE to comply with the convention.

Thus, participants of this part are a smaller group that is five seafarers who have experience in BWTS. The small size of the panel signifies that the validity of the survey is limited and should be seen as indicative but not conclusive.

The interview result can separate into five parts. The amount of respondant is smaller because only little proportion of the world fleet operates with BWMS (see article fairplay mentioned in conclusion).

Part 2 Ballast water operation and maintenance (D-2)

In this part of the information is organized by two main topics that are familiarity with BWM Convention and requirement method, and maintenance method of ballast water operation system.

Part familiarity with BWM Convention including:

Q7 Are you familiar with Ballast Water Management Plan?

![Figure 21 Familiarity with Ballast Water Management Plan D-2. Source: Author](image)

**Comment:** It suggest that most seafarer are familiar with BWMP.
Q8 Are you familiar with Ballast Water Record book?

![Figure 22](image)

Source: Author

**Comment:** It suggest that most of the engine department crews are not familiar with BWRB.

Part of ballast water operation and maintenance method.

Q9 Have you been engaged in Ballast Water operations?

A result of 5 participants answered about the role of engaging in ballast water operation which can categories the answer into three groups as follows.

<table>
<thead>
<tr>
<th>How to engage in ballast water operation</th>
<th>Number (persons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Over all command, recheck plan and approve</td>
<td>1</td>
</tr>
<tr>
<td>2. Over all command in the engine room</td>
<td>1</td>
</tr>
<tr>
<td>3. Supporting operation with monitoring BWMS</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5</strong></td>
</tr>
</tbody>
</table>

*Table 23 Role to engage in ballast water operation of participant seafarer.
Source: Author*

**Comment:** It suggest that most seafarers has been engaged in ballast water operations therefore proper training should be provided on BWMP and BWRB as well as on BWMS.
Q10 Have you been the officer in charge of Ballast Water Management?

**Comment:** This group has only one person who has been designated to be the officer in charge of ballast water by having experience in it about three years. It suggests that most seafarers will have experience in designated in charge of the BWM in Chief Officer ranking.

Responses from Q7 to Q10 confirm that the panel is conversant with BW Operation and a majority of them have directly been in charge of such operation.

Q11 What kind of ballast water treatment system do you use?

In this question asked participants seafarers about BWMS which used when conduct ballast operation.

A result of interview five participants can categories into three different methods as follows.

<table>
<thead>
<tr>
<th>BWMS</th>
<th>Number of participants (Persons)</th>
<th>Describe the detail of technology</th>
<th>Approval status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ozone + Neutralizing Agent</td>
<td>1</td>
<td></td>
<td>1. By flag state</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. By classification such as Nippon Kaiji Kyokai (NK)</td>
</tr>
<tr>
<td>Electric pulse + Chemical</td>
<td>2</td>
<td>Electro-Clean (electrolytic disinfection) system (subsequently changed to Electro-Cleen™)</td>
<td>By flag state such as China</td>
</tr>
<tr>
<td>UV + chemical</td>
<td>2</td>
<td></td>
<td>By flag state such as China</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 24 BWMS method which participants use D-2.

Source: Author
Q12 Is it an approved system?
This question collected data in table 24.

**Comment:** It suggests that BWMS installed were approved by flag state.

Q13 How did you maintain and repair Ballast Water Management system?
In this part intent to get data from participant seafarers about the method to maintain the ballast water treatment system and equipment. By each participant can answer more than one method, and give a detail of maintenance as follows.

<table>
<thead>
<tr>
<th>Maintenance method</th>
<th>Number of participants (Persons)</th>
<th>Detail of maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-board</td>
<td>5</td>
<td>1. Small and regular maintenance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Monthly chemical change</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Check chemical level and condition of the machine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Cleaning filter</td>
</tr>
<tr>
<td>By company</td>
<td>1</td>
<td>1. Repair and electronic repair</td>
</tr>
<tr>
<td>By outsource service</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>1. Maker maintenance service</td>
</tr>
<tr>
<td>Total</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

*Table 25 Maintenance and repair Ballast Water Management system D-2*  
*Source: Author*

**Comment:** According to table 25, every participant has participating in maintenance of BWM equipment and BWMS.

Considering the specificity if each equipment, it suggests that maintenance on BWMS require specialized knowledge and experience by seafarers.
Q14 What do you think about the reliability of Ballast Water Management System?

This part can divide the reliability of BWMS into 5 levels as follows:

- Reliability score of Excellent = 10
- Reliability score of Good = 7.5
- Reliability score of Average = 5
- Reliability score of Fair = 2.5
- Reliability score of Poor = 0

Answers from five participants can be categorized as follows:

<table>
<thead>
<tr>
<th>Brand and model</th>
<th>Number of participants (Persons)</th>
<th>Percent from total</th>
<th>Reliability of BWMS (Score from 10)</th>
<th>Strengths of BWMS</th>
<th>Weaknesses of BWMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ozone + Neutralizing Agent system</td>
<td>1</td>
<td>20%</td>
<td>10</td>
<td>efficient</td>
<td>Harmful to human</td>
</tr>
<tr>
<td>UV + chemical</td>
<td>2</td>
<td>40%</td>
<td>7.5</td>
<td>1. easy to operate 2.effective operation</td>
<td>1. Difficult to use if users are not familiar. 2. Chemical has to change every three months increase maintenance task and cost.</td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
<td></td>
<td>Average score: 7.92</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Comment:** With an average of 7.92, it suggests that most BWMS have a good reliability to deal with BWM operation. However, several issues were reported:

- Most problem with filters and sensors occurs from sediment in water which obstructs the performance of BWMS. This problem occurs in the coastal area and brackish water.
- Most Problem of maintenance BWMS is that chemical maintenance has to be changed in a certain period.
- Harmful of BWMS to the user requires knowledge seafarers for operation.

**Q15 Can you identify the strengths and weaknesses of the Ballast Water Management System?**

This part seafarers have to define the strengths and weaknesses of their BWMS.

**Comment:** BWMS main strengths seem it easiness to operate. However, it also has several weaknesses such as an error in the operation, requiring additional maintenance, and harmfulness to the user.

**Part 3 Training and education (D-2)**

Interview question can be separated into five questions covering all of the training topics. By answer separate into five choices and require for detailing of training method.

Analysis of this part compare participants of each answer with total participants to get the percent of seafarers who have been trained.

In case of participants who answer more than one choice, the score is accounted by the lower answer of training source. For example, if participant answer Self-learning and By Company, the score is accounted into By Company.
Q16 Have you been trained on Ballast Water Management Plan and procedure, and How?

Figure 23 Participants of training in Ballast Water Management plan and procedure D-2.
Source: Author

<table>
<thead>
<tr>
<th>Training method</th>
<th>Number of participants (Persons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self- learning</td>
<td>-</td>
</tr>
<tr>
<td>On-board</td>
<td>2</td>
</tr>
<tr>
<td>By company</td>
<td>1</td>
</tr>
<tr>
<td>By outsource</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total Participants</strong></td>
<td><strong>4</strong></td>
</tr>
</tbody>
</table>

Table 27 Training in Ballast Water Management Plan and procedure D-2
Source: Author

**Comment:** It suggests that shipping companies do not systematically train crew on BWMP and procedures.

Q17 Have you been trained on Ballast Water Record Book, and How?

Figure 24 Participants of training in Ballast Water Record Book D-2
Source: Author
Training method | Number of participants (Persons)
--- | ---
Self-learning | -
On-board | -
By company | 1
By outsource | -
Other | -
Total participants | 1

Table 28 Training in Ballast Water Record Book.
Source: Author

Comment: It suggests that the BWM officer have to be trained by many sources including on-board and company. However, BWRB is not mentioned by the engineer officer who should have principle knowledge on it.

Q18 Do you know the basic requirement of the Ballast Water Management Convention?

![Pie chart showing Yes, 2 and No, 3](image)

Figure 25 Participants of knowledge on basic requirement of BWM convention D-2
Source: Author

| Training method | Number of participants (Persons) |
--- | ---|
Self-learning | 1|
On-board | -|
By company | 1|
By outsource | -|
Other | -|
Total participants | 2

Table 29 Knowledge on basic requirement of Ballast Water Management Convention D-2.
Source: Author
Comment: It suggests that shipping companies do not systematically train crew on BWMS and procedures which may constitute a serious issue when operating and maintaining such complicated systems.

Q19 Have you been trained on other topic related to Ballast Water Management, and how?

![Figure 26 Participants of training in other topics related to Ballast Water Management D-2. Source: Author](image)

<table>
<thead>
<tr>
<th>Training method</th>
<th>Number of participants (Persons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-learning</td>
<td>1</td>
</tr>
<tr>
<td>On-board</td>
<td>-</td>
</tr>
<tr>
<td>By company</td>
<td>2</td>
</tr>
<tr>
<td>By outsource</td>
<td>-</td>
</tr>
<tr>
<td>Other</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total participants</strong></td>
<td><strong>3</strong></td>
</tr>
</tbody>
</table>

Table 30 Training in other topics related to Ballast Water Management D-2. Source: Author

Comment: It suggests that shipping companies provide some training but not to all crew members on other topics relating to BWM.
Q20 Have you been trained on the Ballast water management system that you have on board?

This is additional topic different from the D-1 standard, asking about training in BWMS which was used by seafarers. Answers of participant found that everyone has been trained on BWMS by several methods which can categories as follows.

<table>
<thead>
<tr>
<th>Training method</th>
<th>Number of participants (Persons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-learning</td>
<td>-</td>
</tr>
<tr>
<td>On-board</td>
<td>2</td>
</tr>
<tr>
<td>By company</td>
<td>1</td>
</tr>
<tr>
<td>By outsource</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total participants</strong></td>
<td><strong>5</strong></td>
</tr>
</tbody>
</table>

Table 31: Training in the Ballast water management system D-2.
Source: Author

**Comment:** It suggests that not all seafarers have not been trained on BWMS installed on their ship despite being in contact with their operation and maintenance as suggested in previous questions of the survey. Shipping company should develop training support on BWMS to every seafarer dealing with BW operation or maintenance.

Part 4 Impact on work (D-2)
In this part interview question relating to impact, and issue on ballast water management operation. By separating question cover the scope of the issue into seven questions. Answers are description issue and opinion from experience of seafarers.
Q21 Does new regulation on Ballast Water Management affect your workload?

![Figure 27 Regulation on Ballast Water Management affect to seafarer workload D-2](source)

Answer of 3 participants who agree with BWM convention effect on work load. It can be categorized into 2 different ideas.

<table>
<thead>
<tr>
<th>BWM regulation effect on work</th>
<th>Number (persons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. More maintenance of BWM equipment</td>
<td>1</td>
</tr>
<tr>
<td>2. Additional work due to BWMS operation.</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3</strong></td>
</tr>
</tbody>
</table>

*Table 32 How does BWM convention affect to seafarer work load*

**Comment**: It suggests that new regulations impact on seafarers in D-2 ship standard by increasing workload on operation and maintenance.

Q22 Do you have difficulties in complying with the Ballast Water Management Convention and Ballast Water Management Plan?

![Figure 28 Difficulties in complying with BWM Convention and BWMP D-2](source)
Q23 Do you have any limitation in Ballast water operation such as weather condition, ship stability, ship safety navigation, ship stress, geographic, distance, route, equipment such as flow rate etc. and reliability of equipment?

Most of the participants provided more than one comment. However, the comments can be classified into three topics.

<table>
<thead>
<tr>
<th>No.</th>
<th>Limitation topic</th>
<th>Number of participants (Persons)</th>
<th>A reason for limitation</th>
</tr>
</thead>
</table>
| 1   | Equipment issue    | 5                                | 1. In the coastal area, brackish water, and fresh water, the system will error and cannot treatment by total residual oxidant (TRO) indicator error  
                                            2. Dirty water restrict performance of treatment system |
| 2   | Approval issue     | 1                                | 1. BWMS was not approved by USCG                                                        |
| Total participants | 6                  |                                   | (One respondent provided two answers)                                                     |

*Table 33 Limitation in Ballast water operation D-2*

*Source: Author*

**Comment:** It suggests that BWMS facilitates compliance with the Convention compared to BWE method.

According to the answers of five participants, all of them has experience in limitation to comply with the convention.

Most of the participant has experience on BWMS malfunction in brackish water, dirty water, and fresh water.

It suggests that quality of water influence BWMS functioning. Therefore, approval processes should take this aspect into consideration with great care.
Q24 Have you experienced a problem in applying D2 (Ballast Water Performance)?

Answer of the participants is different as follows.

<table>
<thead>
<tr>
<th>No.</th>
<th>The problem to comply D-2</th>
<th>Number (persons)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ship voyage</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Some country does not approve the BWTS that have to use BWE for the temporary solution.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Equipment</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Sensor malfunction when large plant came into the system.</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Ballast water pump failure</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Unstable system</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Flow meter detect does not relate to the treatment system real flow rate.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 34 Problem to comply D-2 standard
Source: Author

Comment: It seems to indicate that most of the issues to comply with BWM convention of the D-2 standard is an equipment problem.

Q25 Do you think Ballast Water Management operation maybe dangerous?

An opinion of seafarers who agree with ballast water management is dangerous which has three different aspects as following.

Figure 29 Opinion on Ballast Water Management operation may be dangerous D-2
Source: Author
Table 35 Opinion on Ballast Water Management operation may be dangerous D-2
Source: Author

Comment: It suggests that BWMS has high risks on the operation which requires appropriate knowledge seafarer.

Q26 Have you been inspected on Ballast Water requirements (Flag state, Port state, Classification)?

Table 36 Source of ship inspection D-2
Source: Author

Answers of participants can have multiple answers which can categories as follows.
Q27 Do you have additional medical surveillance for checking health in relating to the Ballast Water Management System onboard?

![Pie chart showing medical surveillance results]

**Comment:** It suggests that seafarer on D-2 standard are required more knowledge on BWMS for responding ship inspection.

Part 5 Sediment operation/ Tank inspection (D-2)
Part of sediment removing and ballast tank inspection that involves in ballast water management due to BWM Convention.

Q28 Have you ever been engaged in sediments removing?
A result of interview five seafarer, two of them has experiences to remove sediment when the ship was in dry dock by using shore gang and dock yard service.

**Comment:** According to figure 31, only one person has additional medical surveillance. By giving a reason is that medical check is necessary for a maintenance engineer to use ozone exposure patch.

It suggests that most of the shipping company does not support enough additional medical surveillance due to the risk of BWMS operation.
Q29 Have you ever been engaged in tank inspection?
Tank inspection procedures are in SMS of every shipping company. Thus, the answer of participants have similarities
- Inspect amount of sediment, tank condition sounding pipe air pipe, coating condition, tank ventilation, and Zink anode.
- Ballast tank inspected every six months on half numbers of total tank and covered all of the tanks in one year.
- Using PPE fully

Comment: According to the answers of five participants, all of them has engaged in tank inspection.
From the comment of seafarers suggests that tank inspection is the enclose space operation which has to follow company procedure with fully PPE.

Part 6 Others opinion (D-2)
Q30 Do you have any comment on the impact of Ballast water management on seafarers workload?
In this part is the open-end answer for participants giving the opinion about the impact of Ballast water management on seafarer workload. Form five seafarers have three additional comments which can summary significant idea as follows.
• Seafarers are the willingness to comply with BWM convention but need to support from shipping company on machinery providing and maintenance.

• The standard of BWMS approval is different making the complicated task to the seafarer.

The conclusion of responses related to D-2:

• Training and education: This aspect has the result similar to the D-1 standard. However, one additional result is that the shipping company has no enough qualified training in BWMS to seafarers before joining on-board.

• Difficulties: BWMS can reduce the workload on seafarers to manage BW. However, in case of the failure of BWMS, seafarers may deal with the problem to comply with regulations.

• Problem: Most of the participants found difficulties to comply with the D-2 standard if the equipment is malfunctioning, especially, in coastal areas and brackish water.

• Reliability issues: Most of the participants agree that the BWMS is easy to operate. However, the unstable machinery issue and the different approval standards among the member states make seafarers find difficult to comply with the standard.
Chapter 4 Conclusion

Since the BWM convention entered into force (2017), seafarers’ workload and practices have been affected. Moreover, it does not seems shipowners will add additional crew to deal with the new convention. Therefore, the impacts of convention on seafarers can be categorised as follows.

Firstly, the impact of seafarers on responsibility and maintenance:

This part covers the familiarization, responsibility, operation methods, and maintenance system. As a result, the research found that most seafarers (D-1 and D-2) are familiar with the procedure and plan of BWM operations despite not having been formally trained by a company or manufacturers. For the D-1 group the additional task relating to BWE includes more paperwork and the frequency of BW operations (long hours of work when emptying and refilling). On the other hand, the D-2 group has significantly increased the maintenance task. Moreover, the reliability of equipment and limited approval status (if not USCG approved) of BWMS may cause problems during the BW operation.

Secondly, training and education aspects are important to enhance safe and efficient BWM operations.

Despite new risks related to BW Management requirements, this research found that seafarers have not been specifically trained in BWM operations. Shipping companies should support training and education. Indeed, to face risks related to D-1 and particularly D-2, seafarers should be trained on specific BWMS installed on-board before joining the ship.
Thirdly, overall impacts include seafarers’ workloads and compliances with hours of rest, system limitation, problem related to equipment, the harmfulness of some treatment processes, and inspections. A result of the research indicated that the BWM convention significantly increases the workload on seafarers in every aspect, especially, when dealing with BWE standards. However, it suggests that BWMS can decrease the workload during operations but the lack of reliability and harmfulness of BWMS should be considered. Enhanced support from ship owners is expected. The harmonization of PSC practices should be encouraged.

Fourthly, sediment removal and the tank inspection aspect should be considered:

Most sediment removal processes are conducted during dry docking. In rare cases, ships conduct sediment removal during operations. Ballast Tank inspections constitute routine work onboard and are integrated in the SMS procedure of a shipping company. Such onboard inspections also include sediment inspections. Seafarers may be exposed to significant risks when improperly trained and the shipping company does not support sufficient PPE and Gas free detectors.

Fifthly, to comply with the BWM convention, seafarers need the appropriate knowledge of the regulations.

It will facilitate compliance, avoid inappropriate practices, enhance efficiency and reduce the risks of BWM. Such knowledge in the convention and good practices should be developed by shipping companies.

Lastly, IHS disclosed information showing that about 8,000 merchant vessels on 50,000 ship panels have on board BWMS in compliance with D-2. However, several problems have been reported (John G, 2018). To assess the initial phase of entry into force of the convention and identify issues related to BWMS, the IMO establishes the experience-building phase (EBP – MEPC.290(71) and BWM.2/Circ.67) to research and analyse the situation before considering a package of amendments if necessary in 2022. Additional and extensive research on the implementation of BWM Convention and its impacts on seafarers should be considered in the future.
Finally, the implementation and enforcement of the BWM Convention represents a good signal in the mitigation HAOP risks around the world.
Indicative Bibliography


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APPENDIX A

Interview question of dissertation D-1 (Ballast water exchange).

The impact of Ballast Water Management Convention on seafarer work practices

This interview question is the part of dissertation of Master of Science student in Maritime affairs, specialization in Maritime Safety and Environment protection Administration, World maritime university.

Please be assured that all answers you provide will be kept in the strictest confidentiality. If you have any inquiry please contact Mr. Phanuwat Phiwphan, E-mail: w1701340@wmu.se.

The survey will take approximately 20 - 30 minutes. Your input is highly appreciated and the overall results will be used to analyze the impact from Ballast Water Management Convention on seafarers.

Regards

The interview question for seafarer working with D-1 system (Ballast water exchange).

Part 1 General Information

1. Age: __
2. Which region are you from?
   ☐ Africa ☐ Asia ☐ North America ☐ South America
   ☐ Central America ☐ Eastern Europe ☐ the European Union
   ☐ the Middle East ☐ the Caribbean ☐ Oceania
3. Certificate of competency
   ☐ Master mariner international voyage ☐ Chief engineer
   ☐ Chief officer ☐ 2nd engineer officer
   ☐ Deck officer ☐ 3rd engineer officer
4. Last position on-board: __________________
5. Experience in last position: ______________
6. Total seafarer experience: ______________

Part 2 Ballast water operation and maintenance

7. Are you familiar with Ballast Water Management Plan?
   ☐ yes ☐ No
   If yes, how? __________________
8. Are you familiar with Ballast Water Record book?
   ☐ yes ☐ No
   If yes, how? __________________
9. Have you been engaged in Ballast Water operations?
   ☐ yes ☐ No
   If yes, which role you had? ____________
10. Have you been officer in charge of Ballast Water Management?
□ yes □ No
If yes, how many years? ________________

11. What kind of ballast exchange method which you use?( According to guidelines for ballast water exchange (g6))
□ Sequential (Empty/refill)
□ Flow through
□ Dilution
□ Other:______________
Why you use this method? ________________

12. How did you maintain and repair Ballast Water Management system?
□ On-board, more detail__
□ By company, more detail__________________
□ By outsource service, more detail____
□ Other:______________

Part 3 Training and education

13. Have you been trained on Ballast Water Management Plan and procedure, and How?
□ Self learning
□ On-board training, more detail__
□ By company training, more detail__
□ By outsource training, more detail__________________
□ Other:______________

14. Have you been trained on Ballast Water Record Book, and How?
□ Self learning
□ On-board training, more detail__________________
□ By company training, more detail__________________
□ By outsource training, more detail__________________
□ Other:______________

15. Do you know basic requirement of Ballast Water Management Convention?
□ yes □ No
If yes, how did you know?
□ Self learning
□ Onboard training, more detail__________________
□ By company training, more detail__________________
□ By outsource training, more detail__________________
□ Other:______________

16. Have you been trained on other topic related to Ballast Water Management, and How?
□ Self learning
□ On-board training, more detail___
□ By company training, more detail____
□ By outsource training, more detail__________________
□ Other:_____________

Part 4 Impact on work

17. Does new regulation on Ballast Water Management affect your workload?
   □ yes □ No
   If yes, how does it affect your work? ____

18. Do you have difficulties in complying with Ballast Water Management Convention and Ballast Water Management Plan?
   □ yes □ No
   If yes, why? ____

19. Do you have any limitation in Ballast water operation such as weather condition, ship stability, ship safety navigation, ship stress, geographic, distance, route, equipment such as flow rate etc.?
   □ yes □ No
   If yes, why is it limitation? ____

20. Have you experienced a problem in applying D1 (Ballast Water Exchange)?
   □ yes □ No
   If yes, what was the problem? ______________________

21. Do you think Ballast Water Management operation may be dangerous?
   □ yes □ No
   If yes, why is it dangerous? ______________________

22. Have you been inspected on Ballast Water requirements (Flag state, Port state, Classification)?
   □ yes □ No
   If yes, when did you have an inspection and how? ______________________

Part 5 Sediment operation/ Tank inspection

23. Have you ever been engaged in sediments removing?
   □ yes □ No
   If yes, how? ______________________

24. Have you ever been engaged in tank inspection?
   □ yes □ No
   If yes, how do you inspected and do you have enough Personal Protective Equipment during inspection? ______________________

Part 6 Other opinion

25. Do you have any comment on the impact of Ballast water management on seafarers workload?
   □ yes □ No
   If yes, please explain. ______________________


APPENDIX B

Interview question of dissertation D-2 (Ballast water performance).

The impact of Ballast Water Management Convention on seafarer work practices

This interview question is the part of dissertation of Master of Science student in Maritime affairs, specialization in Maritime Safety and Environment protection Administration, World maritime university.

Please be assured that all answers you provide will be kept in the strictest confidentiality. If you have any inquiry please contact Mr. Phanuwat Phiwphan, E-mail: w1701340@wmu.se.

The survey will take approximately 20 - 30 minutes. Your input is highly appreciated and the overall results will be used to analyze the impact from Ballast Water Management Convention on seafarers.

Regards

The interview question for seafarer working with D-2 system (Ballast water performance).

Part 1  General Information

1. Age: __________
2. Which region are you from?
   □ Africa  □ Asia  □ North America  □ South America
   □ Central America  □ Eastern Europe  □ the European Union
   □ the Middle East  □ the Caribbean  □ Oceania
3. Certificate of competency
   □ Master mariner international voyage  □ Chief engineer
   □ Chief officer  □ 2nd engineer officer
   □ Deck officer  □ 3rd engineer officer
4. Last position on-board: ____________________
5. Experience in last position: ____________________
6. Total seafarer experience: ____________________

Part 2  Ballast water operation and maintenance

7. Are you familiar with Ballast Water Management Plan?
   □ yes □ No
   If yes, how? ____________________
8. Are you familiar with Ballast Water Record book?
   □ yes □ No
   If yes, how? ____________________
9. Have you been engaged in Ballast Water operations?
   □ yes □ No
   If yes, which role you had? __________ __
10. Have you been officer in charge of Ballast Water Management?
    □ yes □ No
    If yes, how many years? ________________
11. What kind of ballast water treatment system do you use?
   Type of system (UV, Filtration, Chemical, Heat, Electric pulse, etc.) ______
   Brand and model__________
   Other details________________

12. Is it an approved system?
   □ yes □ No
   If yes, by who (flag state, classification, etc.)? ______

13. How did you maintain and repair Ballast Water Management system?
   □ On-board, more detail____________
   □ Company supply, more detail_________________________
   □ Outsourcing, more detail_________________________
   □ Other: ______________________

14. What do you think about reliability of Ballast Water Management System?
   □ Excellent □ good □ Average □ Fair □ Poor
   Please provide comment. ______

15. Can you identify strengths and weaknesses of Ballast Water Management System?
   Strengths: ______________________
   Weaknesses: ______________________

Part 3 Training and education

16. Have you been trained on Ballast Water Management Plan and procedure, and How?
   □ Self learning
   □ On-board training, more detail________________________
   □ By company training, more detail______________________
   □ By outsource training, more detail_____________________
   □ Other: ______________________

17. Have you been trained on Ballast Water Record Book, and How?
   □ Self learning
   □ On-board training, more detail________________________
   □ By company training, more detail______________________
   □ By outsource training, more detail_____________________
   □ Other: ______________________

18. Do you know basic requirement of Ballast Water Management Convention?
   □ yes □ No
   If yes, how did you know?
   □ Self learning


☐ Onboard training, more detail__________________
☐ By company training, more detail__________________
☐ By outsource training, more detail__________________
☐ Other:__________________

19. Have you been trained on other topic related to Ballast Water Management, and how?
☐ Self learning
☐ On-board training, more detail________
☐ By company training, more detail__________________
☐ By outsource training, more detail__________________
☐ Other:__________________

20. Have you been trained on the Ballast water management system that you have on board?
☐ yes ☐ No

If yes, how have you been trained? ______________________
☐ Self learning
☐ On-board training, more detail________
☐ By company training, more detail__________________
☐ By outsource training, more detail__________________
☐ Other:__________________

Part 4 Impact on work

21. Does new regulation on Ballast Water Management affect your workload?
☐ yes ☐ No

If yes, how does it affect your work? __________

22. Do you have difficulties in complying with Ballast Water Management Convention and Ballast Water Management Plan?
☐ yes ☐ No

If yes, why? ______________________

23. Do you have any limitation in Ballast water operation such as weather condition, ship stability, ship safety navigation, ship stress, geographic, distance, route, equipment such as flow rate etc. and reliability of equipment?
☐ yes ☐ No

If yes, why is it limitation? __________

24. Have you experienced a problem in applying D2 (Ballast Water Performance)?
☐ yes ☐ No

If yes, what was the problem? __________

25. Do you think Ballast Water Management operation maybe dangerous?
☐ yes ☐ No

If yes, why is it dangerous? __________

26. Have you been inspected on Ballast Water requirements (Flag state, Port state, Classification)?
□ yes □ No
If yes, when did you have an inspected and how? ______________________

27. Do you have additional medical surveillance for checking health in relation to the Ballast Water management System onboard?
□ yes □ No
If yes, how did you have? ______________________

Part 5 Sediment operation/ Tank inspection

28. Have you ever been engaged in sediments removing?
□ yes □ No
If yes, how? ______

29. Have you ever been engaged in tank inspection?
□ yes □ No
If yes, how do you inspected and do you have enough Personal Protective Equipment during inspection? ______

Part 6 Other opinion

30. Do you have any comment on the impact of Ballast water management on seafarers workload?
□ yes □ No
If yes, please explain. ______