BACHELOR THESIS & COLLOQUIUM – ME184841

OPTIMIZATION VESSEL TRAFFIC SERVICES – A COMPARING CASE STUDY OF MERAK VTS IN SUNDA STRAIT INDONESIA AND WARNEMÜNDE VTS IN BALTIC SEA GERMANY

Gianiti Claresta
NRP. 04211541000025

SUPERVISORS :
Prof. Dr.-Ing. Matthias Markert
Dr.-Ing. Michael Baldauf

DOUBLE DEGREE PROGRAM
DEPARTMENT OF MARINE ENGINEERING
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SKRIPSI – ME184841

OPTIMASI VESSEL TRAFFIC SERVICES – STUDI KASUS PERBANDINGAN VTS MERAK DI SELAT SUNDA INDONESIA DAN VTS WARNEMÜNDE DI LAUT BALTIK JERMAN

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NRP. 04211541000025

SUPERVISORS :
Prof. Dr.-Ing. Matthias Markert
Dr.-Ing. Michael Baldauf

PROGRAM DOUBLE DEGREE
DEPARTMEN TEKNIK SISTEM PERKAPALAN
FAKULTAS TEKNOLOGI KELAUTAN
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
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APPROVAL FORM

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BACHELOR THESIS

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

On

Bachelor Program Department of Marine Engineering
Faculty of Marine Technology
Institut Teknologi Sepuluh Nopember

Prepared by:
GIANITI CLARESTA
NRP. 04211541000025

Approved by Supervisors:

Prof. Dr.-Ing. Matthias Markert (M. Markert)

Dr.-Ing. Michael Baldauf (M. Baldauf)

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Prepared by:
GIANITI CLARESTA
NRP. 04211541000025

Approved by
Head of Department of Marine Engineering

Dr. Eng. Muhammad Badrus Zaman., ST., MT.
NIP. 199708022008011007

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Prepared by:
GIANITI CLARESTA
NRP. 04211541000025

Approved by
Representative of Hochschule Wismar in Indonesia

Dr.-Ing. Wolfgang Busse

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This bachelor thesis has been independentely written and no other resources were used than the ones listed. All parts of the thesis have been obtained from other sources by wording or meaning have been marked accordingly. This also applies to drawings, sketches, figurative images and sources from the Internet. I confirm that all data, concepts, design, references, and material in this report owned by Department of Marine Engineering ITS, which are the product of research study and reserve the right to use for further research study and its development.

Name : Gianiti Claresta
NRP : 04211541000025
Bachelor Thesis Title : Optimization Vessel Traffic Services – A comparing case study of Merak VTS in Sunda Strait Indonesia and Warnemünde VTS in Baltic Sea Germany
Department : Marine Engineering

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OPTIMIZATION VESSEL TRAFFIC SERVICES – A COMPARING CASE STUDY OF MERAK VTS IN SUNDA STRAIT INDONESIA AND WARNEMÜNDE VTS IN BALTIC SEA GERMANY

Name : Gianiti Claresta
NRP : 04211541000025
Department : Marine Engineering
Supervising Professor : Prof. Dr.-Ing. Matthias Markert
Co-Supervisor : Dr.-Ing. Michael Baldauf

ABSTRACT

Vessel Traffic Services (VTS) is a shore-based system that supports bridge teams to ensure safety and efficiency of vessel traffic in national waters and to protect the marine environment of a coastal state. According to the International Maritime Organization (IMO), the VTS is implemented by a Competent Authority for an information service, a navigational assistance service, a traffic organization service, and similar allied services by sending out information, warning, advice, or even instruction. Continued growth in the number of merchant's vessels and particular concerns of the navigational area are becoming major issues in the world in the adoption of ship routeing systems. The VTS has recently become a matter of discussion to contributes to safety, efficiency, and sustainability of maritime traffic. The study investigated the role of Merak VTS for Sunda Strait area and Warnemünde VTS for southern Baltic Sea area in optimizing the implementation of VTS. The study collected primary qualitative data through observations and interviews from participants of both VTSs, as well as another VTS unit in Germany. As has been recognized to be the best way in improving safety at sea, it relied on secondary data from the IMO Resolution A.857 (20) and the IALA Guideline 1111 as international regulations concerning the aspects of the human element, the technical, and the administrative work. It also relied on secondary data from the Directorate General of Sea Transportation of Indonesia and the Federal Maritime and Hydrographic Agency of Germany to get familiarized with the operational procedures. The study revealed that the Warnemünde VTS contributes significantly to the safety and efficiency of the traffic and the protection of the environment. Meanwhile, the Merak VTS contributes to the safety traffic and would significantly contribute by adopting the new routeing systems and the mandatory ship reporting systems in the navigational area. The optimal procedures, the advanced equipment, and the well-trained VTS staff are the potentials to improve and optimize the Merak VTS.

Keywords: Vessel Traffic Services, Sunda Strait, Baltic Sea, Optimization, Qualitative Research, IMO, IALA, Human Element, Technical, Administrative Work

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OPTIMASI VESSEL TRAFFIC SERVICES – STUDI KASUS PERBANDINGAN VTS MERAK DI SELAT SUNDA INDONESIA DAN VTS WARNEMÜNDE DI LAUT BALTIK JERMAN

Nama	: Gianiti Claresta
NRP	: 04211541000025
Departemen	: Marine Engineering
Profesor Pembimbing	: Prof. Dr.-Ing. Matthias Markert
Pembimbing II	: Dr.-Ing. Michael Baldauf

ABSTRAK

Vessel Traffic Services (VTS) adalah sistem berbasis darat yang mendukung perwira dek untuk memastikan keselamatan dan efisiensi lalu lintas kapal di perairan nasional dan menjaga lingkungan laut di wilayah pesisir. Menurut Organisasi Maritim Internasional, VTS diimplementasikan oleh pihak berwenang sebagai pelayanan informasi, pelayanan bantuan navigasi, pelayanan pengelolaan lalu lintas, dan pelayanan serupa lainnya dengan mengirimkan informasi, peringatan, saran, atau bahkan instruksi. Peningkatan berkelanjutan dalam jumlah kapal dagang dan perhatian tertentu atas area navigasi menjadi isu utama di dunia dalam penerapan sistem pengarahan lalu lintas kapal. Belakangan ini VTS menjadi bahan diskusi untuk berkontribusi pada keselamatan, efisiensi, dan keberlanjutan lalu lintas maritim. Studi ini menyelidiki peran VTS Merak untuk wilayah Selat Sunda dan VTS Warnemünde untuk wilayah selatan Laut Baltik dalam mengoptimalkan penerapan VTS. Studi ini mengumpulkan data primer secara kualitatif melalui pengamatan dan wawancara dari peserta di kedua VTS, serta unit VTS lain di Jerman. Sebagaimana telah diakui sebagai cara terbaik dalam meningkatkan keselamatan di laut, studi mengandalkan data sekunder dari IMO Resolution A.857 (20) dan IALA Guideline 1111 sebagai peraturan internasional yang berkenaan dengan aspek elemen manusia, teknis, dan pekerjaan administratif. Studi juga mengandalkan data sekunder dari Direktorat Jenderal Perhubungan Laut Indonesia dan Badan Federal Maritim dan Hidrografi Jerman untuk mengenal prosedur operasional. Studi ini mengungkapkan bahwa VTS Warnemünde berkontribusi secara signifikan terhadap keselamatan dan efisiensi lalu lintas serta perlindungan lingkungan. Sementara itu, VTS Merak berkontribusi terhadap keselamatan lalu lintas dan akan berkontribusi secara signifikan dengan mengadopsi sistem pengarahan baru dan sistem pelaporan kapal wajib di area navigasi. Prosedur yang optimal, peralatan yang canggih, serta staf VTS yang terlatih adalah potensi untuk meningkatkan dan mengoptimalkan VTS Merak.

Kata Kunci: Vessel Traffic Services, Selat Sundat, Laut Baltik, Optimasi, Penelitian Kualitatif, IMO, IALA, Elemen Manusia, Teknis, Pekerjaan Administratif

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PREFACE

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Rostock, August 2019

Claresta

Gianiti Claresta

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LIST OF ABBREVIATIONS

AIS	Automatic Identification System
APM	Associated Protective Measure
ASL	Archipelagic Sea Lanes
AtoN	Aids to Navigation
BSH	Federal Maritime and Hydrographic Agency – Germany
CCTV	Closed Circuit Television
COLREGs	Convention on the International Regulations for Preventing Collisions at Sea, 1972
DJPL	Directorate General of Sea Transportation – Indonesia
DSC	Digital Selective Calling
GMDSS	Global Maritime Distress Safety System
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IMO	International Maritime Organization
INS	Information Service
MSCW	Maritime Simulation Centre Warnemünde
NAS	Navigational Assistance Service
NCSR	IMO Sub-Committee on Navigation, Communications and Search and Rescue
PPSA	Particularly Sensitive Sea Area
SMCP	Standard Marine Communication Phrases
SOLAS	International Convention for the Safety of Life at Sea, 1974
SOP	Standard Operational Procedure
SROP	Coast Station Radio/*Stasiun Radio Pantai*
SRS	Ship Reporting System
TOS	Traffic Organization Service
TSS	Traffic Separation Scheme
UNCTAD	United Nations Conference on Trade and Development
VHF radio	Very High Frequency radio, the primary means of communication for VTS and vessels
VTS	Vessel Traffic Services, a shore-based support service for the mercantile fleet in constrained/confined waters
VTS Staff	All VTS staff including operators, supervisor and manager
VTSO	VTS operator

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CHAPTER I
INTRODUCTION

1.1. Background of the Study

Shipping has always been the foundation of the global economy and international trade in the world. It carries nearly ninety percent of goods we need into our regions (George, 2013) and provides livelihoods for various businesses in almost all countries worldwide (UNCTAD, 2018). The Review of Maritime Transport by UNCTAD (2018) forecasting the prospects of seaborne trade continuously grow at 3,8 percent annually between 2018 and 2023. Export trends increased in developed and developing countries. Specifically, Asia appeared as the most global seaborne trade flows with the fastest growth in exports and imports, followed by Europe, the Americas, Oceania, and Africa.

Nevertheless, uncertainty always exists when weighing on a positive outlook. Take into account that all of these goods are carried by sea and are handled by ports. Factors driving uncertainty are regarding the possible safety, security, also cybersecurity incident, whereas increasing look for policy and protection for the trade are necessary. If the global economy depends on the volume of these seaborne trade, the world fleet and the industry that provide the vessels and services are the backbones of that economy (UNCTAD, 2018).

Both maritime safety and security have been the primary concern of the international community, especially the International Maritime Organization. Developing international regulations which are followed by all shipping countries has been recognized as the best way to improve safety at sea. Ship routing system such as Traffic Separation Schemes (TSS), Areas To Be Avoided, and precautionary areas (IMO, 2015) and Vessel Traffic Services (VTS) (IMO, 1997b) are then being introduced to react to this concern. Ship routing has been introduced to facilitate cost-effective and safe seaborne trade. As a component of the maritime transportation system in the port approach, VTS was introduced to support the ship traffic into and out of ports (Praetorius, 2014).

VTS is a shore-based system to ensure safety and efficiency of vessel traffic in national waters and to protect the marine environment of a coastal state by sending out information, warning, and advice or even instruction. Besides, the Fleet Operation Centers (FOC) operated by the shipping company to monitor the progress of the safe and efficient voyages of their ship fleet is another shore-based system affecting vessel traffic.

1.2. Problem Statement

According to the Directorate General of Sea Transportation report released in 2018, significant traffic density that serves national and international shipping with crossing passage of the heaviest ferry traffic in Indonesia is the concern in the Sunda Strait area. There have been collaborative actions between Indonesia and IMO to ensure the safety of navigation and to reduce the event of ship collision by adopting the TSS and SRS. On the other hand, the ecological, social, economic, cultural, scientific, and educational value, as well as international shipping traffic, are on the ascendency in the Baltic Sea area. According to the Baltic Marine Environment Protection Commission guide published in 2016, there have also been collaborative actions by coastal countries of the

Baltic Sea to ensure the safety of winter navigation and to protect the marine environment by adopting TSS, deep-water routes, mandatory SRS, and particularly sensitive sea area. VTS provides valuable services to mariners and follows the implementation of such routing measures. The integration of operational standard that complies with international rules and regulations should be done to achieve this function entirely. However, its establishment may not be done thoroughly. Using the VTS in Merak and VTS Center in Warnemünde as the basis, the main objective of this study is to compare the recently established Merak VTS in Sunda Strait with the Warnemünde VTS monitoring the traffic in Southern Baltic Sea. This thesis will identify gaps and potentials to improve and optimize Merak VTS.

1.3. Research Objective

The research is aiming to achieve the following result:

1. Get to know the present implementation level of Merak VTS in compliance with IMO and IALA regulations in the terms of technical, the human element, and administrative work.
2. Analysis of the accident frequency in case of head-on, overtaking, and crossing situations in the areas of Sunda Strait and Baltic Sea.
3. Identify the gaps and derive recommendations to Merak VTS based on guidelines and the best practice identified in Warnemünde VTS Centre.
4. Figure out the procedures & facilities that have to be prepared to adapt with the newly ratified TSS in Sunda Strait.

1.4. Research Questions

Based on the description above the research questions have been shaped up to address the research area of interest:

1. How is the implementation level of IMO Resolution A.857(20) and IALA Guideline 1111 in terms of existing technical, the human element, and administrative work by Merak VTS?
2. How is the frequency of risk accident in case of head-on, overtaking, and crossing of ships sailing in Sunda Strait and Southern Baltic Sea?
3. What gaps can be identified and what recommendations can be derived that potentially may contribute to improve effectiveness of Merak VTS?
4. What are procedures and facilities that have to be prepared since IMO has ratified the TSS in Sunda Strait?

1.5. Significance of Study

Sunda Strait is identified as the congested crossing lane and some fatal accidents have been recorded in the area. The research for considering the establishment of routeing measures and ship reporting systems in Sunda Strait have been conducted by Sunaryo, Priadi and Tjahjono (2015) and Sobaruddin, Armawi and Martono (2017), as well as the official document of the proposal to IMO through NCSR 5th session (2017). Though, the research with a focus on everyday performance to highlight the service contribution to the safe navigation of vessel traffic within VTS approaches has not been conducted. This study is significant because it will help understand how the optimal design, installation, and operation of Merak VTS as the shore-based system that can substantially contributes to safety, efficiency, and sustainability of maritime traffic.

1.6. Scope and Limitation

The scope of the study is limited to the contribution of the VTS as a shore-based service and will not address pilotage or navigation onboard vessels in detail. The IMO Resolution A.857(20) and IALA Guideline 1111 that provides the guidelines for vessel traffic services are categorized into three categories, in terms of technical, the human element, and administrative work. The study would rely on direct observation and archive documents from Merak VTS for the compliance of regulations. The compliance defined the focus of the study to assess qualitative research in Merak VTS as well as in Warnemünde VTS to identify the best practice. The fleet data for risk accident assessment was taken from AIS data in Merak VTS in one year period of 2017. However, in coordination with the supervisors, the point of this task did not proceed.

1.7. Structure of Thesis

The study is divided into six chapters. In Chapter 1, the background and research problem are presented. This chapter mentioned the relationship between the increasing maritime traffic with the compelling need of safety for all coastal states and their port as well as the research problem and objectives, significance of the study, scope and limitations. In Chapter 2, the research methods were discussed. This chapter also explained the reasons for choosing a qualitative method, case study, as well as observation and interview. Chapter 3 reviewed international rules and regulations and VTSs in both area. The review focused on the importance of international guidelines to be complied by VTS. In addition, the present situation of both VTSs were also addressed. Chapter 4 discussed the compliance of Merak VTS implementation to the international rules and regulations. Further research of this preliminary study was presented in Chapter 5. The discussions aimed to answer the objectives of the study. Chapter 6 presented a summary of the results in Chapter 5. It stated the major findings of the study and also recommended the outlook idea for future studies.

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CHAPTER II
RESEARCH METHODS

This chapter presents an overview of the methodological approach to be applied in this thesis but also for follow-up research. It introduces the sources of data, the research approach, the research participants, the methods used during the data collection process, the observation, the observation principle, the interview, the interview procedure, the limitation, and ethical issues.

2.1. Sources of Data

For the research in this thesis, data will be collected from both primary and secondary sources for the study. Primary data is the original information based on a particular investigation. According to SAGE (2010): "Primary data is collected firsthand by the researcher for a specific purpose or project and can be collected in several ways." The most common techniques are surveys, interviews, field observation, and experiments (Salkind, 2010). On the other hand, secondary data refers to data that has already been gathered by someone else (IWH, 2015). According to ACAPS (2012): "Secondary data is information which has typically been collected by researchers not involved in the current assessment and has undergone at least one layer of analysis prior to inclusion in the needs assessment. Secondary data can comprise published research, internet materials, media reports, and data which has been cleaned, analyzed and collected for a purpose other than the needs assessment, such as academic research or an agency or sector-specific monitoring reports." Because primary data is quite expensive and time-consuming, in this thesis, the secondary data collection is a main source of information. The literature review was applied for identifying shortcomings and gaps that needed answers. It provides essential information about procedures, requirements, and the services of VTS.

Particularly, the following secondary data was used in this research: Standard Operational Procedure on Merak VTS by DJPL (2015), VTS Guide Germany by BSH (2018), the IMO Resolution (1997b), the IALA publications (2015a and 2016), and Praetorius (2014). The SOP of Merak VTS and VTS Guide of Germany provided the guidance materials for procedures, equipment, also services provided by the VTSs under consideration in this thesis. Publications from IMO and IALA served the international requirement standard in fulfillment of VTS. The research from Praetorius is used to identify the nature of VTS in everyday operation in Northern Europe.

2.2. Research Approach

It is crucial to understand the chosen method to get to know how it works and how to generate output which can answer the research question. The ACAPS (2012) stated that "qualitative research explores information from the perspective of the investigated groups and individuals and generates case studies and summaries rather than lists of numeric data." Meanwhile, qualitative research is exploratory defined. The quantitative research methods can be analyzed numerically and presented using statistics, tables, and graphs. The qualitative research method is recommended during earlier phases of assessments. Meanwhile, quantitative research method is for the latter phase of assessment. In order to achieve the goals of this research, a qualitative research method is employed in gathering the primary data.

There are some benefits of using qualitative research approaches and methods. Qualitative research approach emphasizes a holistic approach about affected populations (ACAPS, 2012). When it is used, the data gathered is often presented in the form of a case study. However, results through qualitative methods can also be presented in graphs, tables, and using other quantitative methods. According to Corbin & Strauss (as cited in Rahman, 2017), the discovery of participant's inner experience, also to figure out how meanings are shaped through and in culture can be done by the qualitative research. The most commonly used methods for collecting data are participant-observation, unstructured interviews, direct observation, and describing records (Cohen et al., 2011, as cited in (Rahman, 2017)).

During the data collection, the researcher interacts with the participants directly as well as data collection through interviews. Therefore, data collection is subjective and detailed. At this study phase in Merak VTS and Warnemünde VTS Center, a research method that is carefully considering the condition of participants is expected to create better results than to select the participants to answer the qualitative question randomly. This research method can provide rich and detailed information in a limited time and resources.

2.2.1. Case study

The case study is one of the most frequently used methods in the field of qualitative research. Though, case studies may also be quantitative or a combination of both. According to Stake (as cited in Starman, 2013), a case study is a choice of what to be studied for the time being. It has been used in the social sciences and is valuable in practice-oriented fields such as education, management, public administration, and social work. The case an in-depth exploration from multiple perspectives of the complexity and uniqueness of a particular project, policy, institution, program or system in a 'real-life' (Simons, 2009)."

The case study is one of the most frequently used methods in the field of qualitative research. Though, case studies may also be quantitative or a combination of both. According to Stake (as cited in Starman, 2013), a case study is a choice of what to be studied for the time being as analytically, holistically, hermeneutically, culturally, and by mixed methods. It has been used in the social sciences and is valuable in practice-oriented fields such as education, management, public administration, and social work. In addition, "Case study is an in-depth exploration from multiple perspectives of the uniqueness and complexity of a particular project, policy, program or system in a 'real-life' (Simons, 2009)."

The researchers need a set of two or three narrowed questions that will help structure the observation, interviews, and document review (Stake, 1995). Observation would lead them to have a greater understanding of the case. The case will not be seen the same by everyone and the interview would be the way to multiple realities. He further added that "Each researcher needs, through experience and reflection, to find the forms of analysis that work for him or her." The more qualitative approach would find good patterns to reveal the unique complexity of the case. This methodological knowledge comes from hard work under recognizing good sources of data, critical examination, and significant

understanding (Stake, 1995). Still, novice researchers than experts would need more guidance since they do not have so many experiences yet (Yazan, 2015).
On this thesis, a preliminary study to help research in seeking patterns of data and narrowing the issues about the operational, technical, and human element of Merak VTS were done. On the later stage, the main case study would elaborate the developed essential issues which have been gained from the preliminary study. This study resulted a narrative or descriptive account of settings or practices of VTS in Merak VTS and Warnemünde VTS Centre.

2.3. Research Participants

Key informant interviews or semi-structured interviews provide vital information on individual perspectives and experiences through direct discussion. A key informant is a source of primary data with prior knowledge of the issues in the affected community. The data collected can be combined and analyzed to gain an understanding of how, why, and what aspects or priority have been in concerned or needed over time (ACAPS, 2012). This research was done primarily with key informants who are responsible for particular VTSs in Indonesia and Germany.
The WSA Stralsund in Germany and DISNAV Class I Tanjung Priok are the responsible authority for shipping, infrastructure, and inland maritime navigation. In order to collect information from different perspectives and experiences, fourteen participants were interviewed from Merak VTS and Warnemünde VTS, as well as from the other VTS unit in Germany to get an idea of VTS in general. The participants were selected to answer questions on phone interviews and in face to face interviews, respectively.

2.4. Data Collection Process

Stake (1995) stated that the research needs to have a strong advance plan in both gathering observation data and in doing the interview. He added, "What is observed usually is not controlled by the researchers. In opposite, what is covered in the interview is targeted and influenced by the interviewers." ACAPS (2011) also agree by stating that, "Observation may generate questions for further investigation and help form future discussions or frame questions in case of inconsistency between what the interviewer of a key informant observes and what the respondents are saying." Both direct observation and key informant interviews are typically used together for maximum impact during the collection of primary data (ACAPS, 2011).
This study collected the data through observation and interview. Besides, archive documents related to management and technical aspects were also requested to complete the data from the qualitative method.

2.4.1. Archive documents

The archive documents are the secondary data that have been received from organizational records. This study collected several archive documents related to Merak VTS and Warnemünde VTS Center to fulfill incomplete information for compliance with international rules and regulations, which are:

1. Standard Operational Procedure of Merak VTS (2015);
2. VTS Guide Germany (2018);
3. Fleet data in Sunda Strait of 2016-2018;
4. VTS Equipment and AtoN of Merak VTS (2019); and

5. Qualification of VTS staff in Indonesia.

The SOP of Merak VTS (DJPL, 2015) is the national procedure of Merak VTS operation to cover the Sunda Strait area. It provided information about Merak VTS in general, the provided services, the internal procedure to be complied by VTS staff, and the external procedure to be complied by ships.

The VTS Guide Germany (BSH, 2018) is the national procedure of VTS operation to cover all Germany waterways area and therefore included Warnemünde VTS Center. It provided information about five sectors of Warnemünde VTS Center, the provided services, and the procedures to be complied by ships.

The fleet data was taken from AIS data provided in Sunda Strait area covered by Merak VTS and ASDP Ferry Company. The database was a daily logbook started from January 2016 until August 2018 and contained the static data and voyage related information, e.g. IMO number, call sign, MMSI, lasport, and destination. The recapitulation of these logbooks has been made and completed with more detail information such as length, draught, speed, and type of ships, included the type of ships required in iWRAP.

Information describing the VTS equipment and AtoN in Sunda Strait has also been investigated and is obtained from Merak VTS. The equipment consisted of land-based radar, AIS, long-range camera, VHF radio, weather station, communication, VTS software, server, and radio direction finder. Meanwhile, the AtoN included the lighthouse, buoys light, and beacons light.

Information describing the qualification of VTS staff in Indonesia elaborates requirements for the position as manager, supervisor, operator, administrator, and technician of VTS. It describes, among others, the requirements of VTS staff within several criteria, which are positions as a civil servant, educational background, and period of experiences in VTS.

2.5. Observation

Direct observation or participant observation is achieved by observing conditions and particular conditions from various point of view and locations to provide an overall view of the affected area and by taking the result in a checklist (ACAPS, 2012). Through this thesis, direct observation (study visits) and participant observation were accomplished in Merak VTS, Warnemünde VTS, and Maritime Simulation Center Warnemünde (MSCW) to get the idea of the daily operation of VTS in Indonesia and Germany.

2.5.1. Direct Observation

According to ACAPS (2011), there are are two approaches to direct observation, which are structured observation and unstructured observation. An open-ended question, which can develop an unstructured observation (ACAPS, 2011), does not have a limited concept or hypothesis prior to the process of data collection, which aim to observe what is out there (Patton, 2002). Moreover, it is impossible to capture all aspects of the context in a single observation. Within the case, there are two ways to overcome the captivity (Darwin, 1969, as cited in Corbin and Strauss, 2015). He added, "One is to ask oneself all kinds of questions about what he is studying, even seemingly ludicrous questions. The other recommended procedure is to record all observations that challenge one is working conception as well as any observation that is odd and interesting even though its relevance is not immediately clear (p. 41-42)." On the other hand, in structured observation, the observer is looking for specific attitudes, object, or event. A checklist is usually developed to be a reminder and recording tool (ACAPS, 2011).

At the beginning of this research, the first study visits are conducted in Merak VTS and could be characterized as open-ended questions of unstructured observation. The second visits conducted in Merak VTS, as well as visits in MSCW and Warnemünde VTS, were structured observations.

2.5.2. Participant Observation

One of the essential matters as an observer is to consider the degree of participation carefully. There is some degree of participation during the observation, which are active or passive. For example, the participants are completing the same training program or are participating in shift work but not involved in actual work as an operator (Repstand, 1999, as cited in Praetorius, 2014).

The participant observation was conducted in both Merak VTS and Warnemünde VTS to get the idea of the personnel in each VTS.

2.6. Observation Principle

The study visit in Merak VTS on the beginning of this research was conducted based on the finding from literature, the discovery of available data sources, and the identification of research problem. The unstructured observation was intended to have a deeper understanding of the VTS system, operation procedure, technical equipment, and the operators providing the service.

On the second study visit in Merak VTS, the research problem of VTS has been set and prepared. Also, the listed regulation as the checklist has been developed to be brought an on-site visit. This observation was structured and aimed to fulfill the information, which can identify the gap of compliance, between the implementation of Merak VTS and guidance from selected international guidelines, which are IMO Resolution A.857 (20) and IALA Guideline 1111. This observation resulted in the preliminary case study consists of compliance of Merak VTS in technical aspects, human element aspects, and administrative work. The study is presented in Chapter 4.

The latter observation was done in MSCW and Warnemünde VTSC in Germany. This study visit can be categorized as direct observation and participant observation and aim to know how the VTS Operators provide the service through simulation training and real operation. This observation added information about the operation and the training scheme of VTS in Germany.

2.7. Interview

This study used in-depth interview technique in collecting data from the participants. The open-ended interview offers the interviewer with the ability to ask the question in different ways and from different angles (Praetorius, 2014). ACAPS (2012) stated that "Primary data is most often collected through face to face interviews or discussions, but can also be gathered through phone interviews, radio communication, email exchange, and direct observation."

2.7.1. Informal conversational interview

Informal conversational interviews are spontaneous interviews based on questions that arise from the context delivered by the informant. Observations are most commonly done with this type of interview, allowing the researcher to obtain knowledge to explore a wide range of aspects of a situation (Patton, 2002).

All observation and study visits were accompanied by informal conversational interviews. The aim was to provide a better understanding of the actions taken by the informants and the meanings attached to them.

2.7.2. Semi-structured interview

Semi-structured interviews enable researchers to maintain consistency over the pursued concept during the interview (Flick, 2018). It involves an interview guide, topic to be discussed, and a list of questions, which provides flexibility to do follow-up questions or change the questions order. Therefore, the respondent has the opportunity to clarify the answers, and in-depth information can be obtained (Patton, 2002). These interviews were done to provide primary data of the VTS.

2.8. Interview Procedure

Texting was made to the participants of Merak VTS to establish contact for interview and time to be arranged. The interviewee was humbly asked whether they would prefer to be interviewed on the phone or receive a link that would lead them to Google Docs. Meanwhile, the interviews with participants at MSCW and Warnemünde VTS were done with face to face meeting.

The participants of VTSs were introduced about the research goal and were also informed that all collected data would be treated with confidentiality. The consent form was also introduced which can be seen in Appendix B.

Apart from the introduction, the primary investigation was structured into 15 questions. The interview questions were carefully designed to cover the objectives of the study and particularly developing essential issues from the conducted preliminary study. The study intended to investigate how is the implementation level of VTS by compliance with rules and regulations; to identify training scheme and operational procedures; to identify VTS capabilities in increasing maritime safety through navigation in the area, and derive recommendations for the identified potentials of the system.

The main questions that were used for the interviews in both VTSs are discussed below. The detail version of the questions is guided in Appendix C.

1. *What is your background?*
2. *How is the recruitment process, the qualifications and the training scheme for VTS staff?*
3. *How is the operational working hour for VTS staff?*
4. *Are there regulations that VTS authority are expected to comply?*
5. *Are there regulations that vessels are expected to comply?*
6. *How is the response of participating vessels to the VTS?*
7. *What kind of enforcement or fine is charged to vessels when they do not comply with VTS regulatory requirements?*
8. *Are there any targeted areas during VTS operations? (e.g. restricted zone, laying pipeline, TSS)*
9. *What are the Allied Services of VTS and how is the coordination?*
10. *What are the equipments used to support the monitoring in the navigational area?*

11. *What are the communication mediums used to contact and communicate with vessels and between VTS centres?*
12. *What contributions are given by VTS to ensure safety and efficiency of maritime traffic and the protection of the marine environment?*
13. *What kind of publications has to be provided to enable mariners with full details of requirements and procedures in the area of VTS?*
14. *What are the potential areas for improvement of VTS?*
15. *What facilities, equipment, or systems are significant during the implementation of mandatory SRS and TSS?*

2.9. Limitation

This study adopted a definition of safety and efficiency of maritime traffic and the protection of the marine environment. This concept can be improved if VTS was established and operated following internationally approved guidelines. Despite many guidelines, rules, and resolutions that have been published, the study is guided by IMO Resolution A.857(20) and IALA Guideline 1111. Limited fleet data to find risk accident frequency on head-on, overtaking, and crossing situations in the Baltic Sea. Only fleet data based on AIS data of shipping for the entire year of 2017 in Sunda Strait was readily available on this thesis. The representative of recapitulation can be seen in Appendix E, and the detail is presented on Microsoft Excel software provided on the attached CD.

2.10. Ethical Issues

All researchers have to put a strong concern to the ethical and data protection issues. The participants, research, and researcher are the three major areas for ethical consideration (Corbin and Strauss, 2015). In essence, the five major principles of ethics that every research should address include informed consent, confidentiality, data use, and destruction, respect the principle of proportionality, and use expertise in case of sensitive projects (Commission, 2013). This study will seek the consent of every participant and allow him or her to withdraw from the interviews at any point they wish to do so. All data acquired was treated with confidentiality. Interviews were also done in professional manner to protect participants from any harm.

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CHAPTER III
LITERATURE STUDY, LEGAL FRAMEWORK AND RELEVANCE

3.1. State of the Art

In this state of the art, the previous study that guides this thesis is from Gesa Praetorius with the thesis title "*Vessel Traffic Service (VTS): a maritime information service or traffic control system?"* (Praetorius, 2014). In the mentioned thesis, the discussed topic was mainly about the everyday performance of the VTS system, especially how to increase and identify its service modeling.

Another study that also guides this thesis is from Joseph Akwasi Kuma with the dissertation's title "*Vessel traffic service as a maritime security tool: vessel traffic management information systems (VTMIS) in Ghana"* (Akwasi Kuma and Akwasi, 2015). This study mainly discussed about the contribution and capabilities of VTS, the shortfalls of its use and ways to overcome.

The difference with these theses aside the location of VTS, are the previous studies did not analyze based on the rules implementation and risk assessment. This thesis is more focused on the implementation of rules in the operational procedure, functions, equipments, and risk assessment.

3.2. Regulations Framework

The earliest AtoN were shore-side beacons and lights, followed by the introduction of buoys. Over the years, these aids have been improved with greater visibility, range, and the addition of audible signal. These early systems were intended to minimize traffic delays and increase the efficiency of traffic flow in general, but then they continue to give attention to the number of shipping accidents and how to reduce these accidents. The concern that such disasters might happen in port approaches and port areas furtherly expanded the use of radar surveillance and the management of vessel traffic (IALA, 2016).

IMO recognizes the ultimate value of VTS in the management of potentially high-risk geographic areas and protection of the environment. While VTS should able to interact with the traffic and to respond to traffic situations developing in the VTS area, IMO identifies three types of services provided by VTS consists of Information Service (INS), Navigational Assistance Service (NAS), and Traffic Organization Service (TOS) (IMO, 1997b). An INS is the basic service of all VTS to provide waterways conditions, weather, or other information that may influence the vessels. Meanwhile, a TOS is relevant to provide service in the high traffic density area. The VTS Authority could organize and manage traffic by providing space allocation and prevention of accident. In the time of difficult navigational or any other circumstances in a particular area, the provision of NAS is essential to provide advice to vessels. All of the services have to provide marine information, by broadcasting or as requested, and by using VHF as the primary communication means or any available means within the mobile maritime service of its VTS (IALA, 2016).

As the number of VTS is increased throughout the world, the operating concepts have led VTS to be established and to cover rivers, inland waterways, ports or harbors, and coastal waters. The regulating traffic can be managed by active interaction with the VTS center, by passive monitoring by the TSS utilization, or both (IALA, 2016).

At first, VTS was not explicitly referred to in the SOLAS 1974. However, in June 1997, the IMO's MSC adopted a new regulation to Chapter V Safety of Navigation, which set out when a VTS can be implemented. This Chapter offers 35 regulations as practical guidance for ship owners, masters, crew, and industry (IMO, 2014). The focus is mainly in services, such as SAR and VTS; navigation, such as routing, reporting systems, nautical charts and publications; and the equipment (Baldauf, 2019).

As regulated in SOLAS V/5-7, contracting governments are required to establish SAR systems for communication, coordination, and for the rescue of persons in distress at sea around its coasts. When contracting governments initiated to establish mandatory systems for routing system and SRS, they shall refer Ship's Routing Systems (V/5-10), and Ship Reporting System (V/5-11) to IMO for adoption and ships shall use the systems unless there is a compelling reason not to. In SOLAS V/5-12, contracting governments may establish VTS where the traffic volume or risk justifies such services. The use of VTS can only be mandatory in territorial seas and shall follow the guideline adopted by IMO in Resolution A.857(20). In accordance, vessels shall comply with Shipborne Navigation Systems (V/5-19) which comply with relevant IMO Performance Standards. The SOLAS V/5-27 stated that all nautical charts and publications shall be adequate and up to date. These include sailing directions, lists of lights, notices to mariners, tide tables, and all other necessary nautical publications for the intended voyage (IMO, 2014).

The successful organization and provision of VTS clearly states a need for international agreement from which all vessels can harmoniously and successfully interact. There is also a need for national and regional regulation to adjust these international objectives with their particular area (IALA, 2016).

3.2.1. Guidelines for Vessel Traffic Services [Resolution A.857(20)]

Based on the IALA VTS Manual (2016), the mission of IMO as a United Nations specialized agency is to promote safe, secure, environmentally sound, efficient, and sustainable shipping through cooperation. Nevertheless, the Maritime Safety Committee (MSC) is the highest technical body of the Organization, which consists of all current Member States. The functions of the MSC are to consider any matter within the scope of IMO concerned with AtoN, construction and equipment of vessels, manning from a safety standpoint, rules for the prevention of collisions, handling of dangerous cargoes, maritime safety procedures and requirements, hydrographic information, log-books and navigational records, marine casualty investigations, salvage and rescue and any other matters directly affecting maritime safety. Therefore, the adoption of TSS and APM for PPSA are to be considered by MSC before approval by IMO.

In 1985, IMO adopted a resolution addressing the operational procedures and planning for VTS with Resolution A.578(14) – 'Guidelines for Vessel Traffic Services.' This Guidelines did not address liability or responsibility of authority also the staff of VTS. Therefore the updated version of IMO Resolution was adopted in 1997 with IMO Assembly Resolution A.857(20) – 'Guidelines for Vessel Traffic Services' which is the current internationally recognized source policy and regulatory document for VTS. Competent Authority adopts this resolution as a service implemented, to improve the safety and efficiency of vessel traffic flow, and to protect the marine environment (IMO, 1997b).

The IMO Resolution A.857(20) consists of two Annexes. The Annex I –'Guidelines and Criteria for VTS' describes the principles and general operational provisions for the operation of a VTS and participating vessels which should be taken into account by Contracting Government when planning, implementing and operating VTS. The Annex II –'Guidelines on Recruitment, Qualifications and Training of VTS Operators' describes the skill and knowledge qualifications required by VTS operators to provide the services which have been mentioned in Annex I. Through this thesis, the guidance of IMO Resolution A.857(20) was used to consider the operational implementation of VTS and management of operators as VTS staff.

3.2.2. Preparation of Operational and Technical Performance Requirements for VTS Systems [IALA Guideline 1111]

According to the IALA VTS Manual (2016), IALA maintains solid links with IMO and is recognized as a Non-Governmental Organization (NGO) with consultative status. IALA aims to foster the safe, economical, and efficient movement of vessels, through improvement and harmonization of AtoN worldwide and other appropriate means.

The IALA Guideline 1111 – 'Preparation of Operational and Technical Performance Requirements for VTS Systems' was published in May 2015 and provides detailed guidance to assist the VTS Authority in preparing the definition, specification, establishment, operation and upgrades of a VTS system. The implementation of VTS requires consideration of several aspects, such as locations, sensor and radio coverage, radar target characteristics, sea states, climatic categories, wind conditions, infrastructure, the environment, applicable regulations, approval standards and security (IALA, 2015a).

According to the Regulation of Transportation Ministry of Indonesia about Shipping Communication, which is written in Article 17 Number 4 of *Peraturan Menteri Perhubungan PM 26 Tahun 2011*, VTS equipment refers to the standard listed in the IALA Recommendation V-128 about 'Operational and Technical Performance Requirements for VTS Equipment.' The Recommendation states that the updated version and detailed information, including options, best practices, and suggestions for planning and operating VTS systems can be seen in IALA Guideline 1111 (IALA, 2015b, 2015a). Through this thesis, IALA Guideline 1111 Edition 1.0 is used to consider the technical implementation of Merak VTS, to give attention and awareness to the current technical VTS requirements from IALA.

3.2.3. IALA VTS Manual

While it is for governments to determine how best to enact international agreements within the framework of national legislation, it is evident that some broad similarities emerge in the way that States undertake this responsibility. Most governments find it necessary in the maritime context to rely on two large bodies of primary legislation, one concerned with its flag shipping such as marine, shipping, merchant shipping laws or acts, and the other with its geographical jurisdiction such as harbor, ports, docks laws or acts (IALA, 2016).

The European Union (EU) established a Vessel Traffic Monitoring and Information System along the coasts of Member States under EU Directive 2002/59/EC – 'Establishing a Community Vessel Traffic Monitoring and Information System.' The Directive seeks to improve responses by authorities to incidents, accidents, or any dangerous situations at sea. It also includes the search and rescue operations, prevention, and detection of pollution by ship. The Directive establishes SafeSeaNet as the reporting system between the Member States and imposes reporting obligations on the Member States and port authorities (IALA, 2016). As well as the EU, Indonesia under the Directorate General of Sea Transportation (DJPL) is following SOLAS Chapter V/12 and IMO Resolution A.857(20) to contribute to maritime safety by the presence of VTS. The DJPL established twenty-one VTSs in Indonesia (Departemen Perhubungan, 2018).

As the representatives of most world's leading national maritime authorities formed in 1981, the VTS Committee updates the guidance and advice to assist authorities considering the implementation of new VTS or the upgrading of an existing service. The VTS Manual is intended to be a comprehensive source of reference on VTS policy to meet the needs of the profession and those responsible for managing its activities (IALA, 2016). Through this thesis, the guidance of the sixth edition of IALA VTS Manual is used as supporting guidance to derive recommendations of present services in Merak and Warnemünde VTS.

3.3. Merak VTS

Indonesia has 21 VTS station in the entire territory, which are located in area of Belawan, Batam, Teluk Bayur, Palembang, Jakarta, Merak, Panjang, Semarang, Surabaya, Benoa, Lembar, Pontianak, Banjarmasin, Batu Licin, Samarinda, Balikpapan, Makassar, Bitung, Sorong, Dumai, and Bintuni (Departemen Perhubungan, 2018).

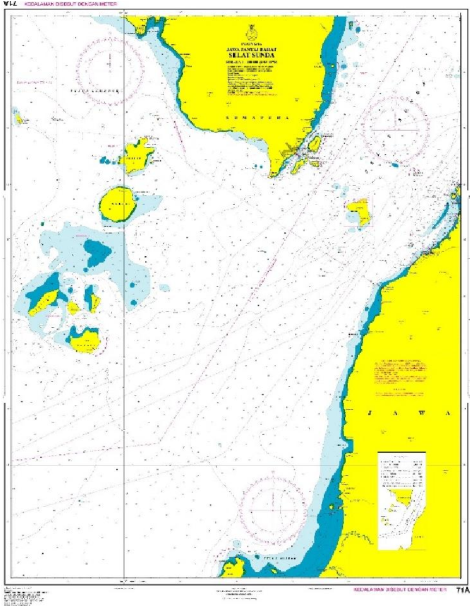

Figure 3.1 Overview Chart of Sunda Strait
(Source: *Pushidrosal*)

Since 2015, the DJPL has installed VTS equipment and assigned Merak VTS to provide service for shipping in Sunda Strait area. The development itself is based on national regulations which are *UU* No. 17 the Year 2008 about *Pelayaran, PP* No. 51 the Year 2002 about *Perkapalan*, *PP* No. 61 the Year 2009 about *Kepelabuhan*, *PP* No.5 the Year 2010 about *Kenavigasian*, and *PM* No. 26 the Year 2011 about *Telekomunikasi Pelayaran* (DJPL, 2015).

According to the DJPL (2015), the operational area of Merak VTS consists of 7 public ports, which are Merak, Bakauheni, Cigading, Ciwandan, Indah Kiat, Indolatex, Panamax and Cape size, also 6 Anchorage area, which are Merak Port, Cigading, Ciwandan, Indah Kiat, Indolatex, Panamax and Cape size. Merak VTS is located in 5°56'0.77"S / 105°59'58.77"E and crossed by the Archipelagic Sea Lanes I of Indonesia (DJPL, 2015).

3.3.1. Environmental condition

For the weather in Sunda Strait area, the averaged precipitation between 2001-2010 is 150 mm (BMKG, no date a), and sometimes rainfall happened (Pushidrosal, 2018). In general, the wind and wave height in the southern part of Sunda Strait is greater than in the northern part (BMKG, 2019). There is no report for the recorded average visibility in the Sunda Strait area. However, according to the observed visibility by the Climatology Station of Serang, the average daily visibility distance was constantly 5,000 meters or internationally estimated as moderate visibility (BMKG, no date c).

The Sunda Strait is categorized from smooth into the very rough sea state. The wave is between 0.74 to 3.23 meters (Sandro *et al.*, 2014). When affected by the Australian monsoon, the highest waves occurred in the Indian Ocean southwest of Indonesia by the height of 3-6 meters per year and generally occurred in July until August (Putra, 2015). The average tidal wave is equal to 0.7 meters (Sandro *et al.*, 2014).

Ocean current plays an essential role for the sea surface temperature (SST), especially in Sunda Strait which is passed by the current from the Indian Ocean and much dependent with the change in the Indian Ocean Dipole (IOD) index (Habibie and Nuraini, 2014). In Sunda Strait, the average ocean current velocity per season in 2007-2008 was 0.5 m/s (Sandro *et al.*, 2014). The SST has been recorded as a positive anomaly in almost all parts of Indonesia during 1981-2010 as 26 °C. As the islands surrounding the Sunda Strait area, the anomaly in Banten and Lampung province reached up to 0.77 °C and 0.18 °C accordingly in 2018 (BMKG, no date b).

For the wind, the average wind speed in the Sunda Strait is categorized as light into gentle breeze (2.5 to 4.9 m/s) or force 2 into 3 in Beaufort scale, but it escalate into moderate breeze (>5,0 m/s) or force 4 in Beaufort scale in May and in time of the Australian monsoon (Sandro *et al.*, 2014).

Sunda Strait was not listed as the area having significant and damaging earthquake potency in Indonesia. However, the history in 1883 proved that a massive eruption of Krakatau Volcano claiming 36 thousand lives without any recorded earthquake magnitude prior to the incident. It reached up to 8 km^3 and propagated the biggest wave into the area of Sunda Strait (Sadly *et al.*, 2018).

The Sunda Strait has a complex variation of bathymetry contour (IMO, 2018). It has varying depth from 30 meters to 100 meters, including angular sub-basin and steep slopes. There are several shallow sites, one of them is in Merak harbor area compared to Bakauheni area (Sunaryo, Priadi and Tjahjono, 2015). The bathymetry of the Sunda Strait constructed of four main ridges, two grabens, protected area, also coral reefs which located approximately 1 nm northeast of the ASL I centerline (IMO, 2018).

The coral reef, namely Koliot Reef, will potentially increase the event of groundings for the ships that pass through the ASL I, going between the Indian Ocean and the Java Sea. Sunda Strait also contains flora and fauna nature conservation areas and several dangerous active volcanic area which had the biggest eruption in history and has the potency of the hazardous eruption at any time. Besides, there is a Navy Training Area located in Lampung Bay (IMO, 2017).

3.3.2. Historical development

According to the regulation of the Ministry of Transportation (Menteri Perhubungan Republik Indonesia, 2011), there are several facilities necessary to maintain the ship traffic, which are AtoN, VTS, and Coast Radio Station (SROP). All ships sailing through Indonesian waterways have to report their identity and voyage information to the Ministry of Indonesia through SROP, VTS, or National Data Center (Menteri Perhubungan Republik Indonesia, 2011).

In the 1980s, Cigading SROP has started its operation to receive information from all ships in Sunda Strait area by having Global Maritime Distress and Safety System (GMDSS), consists of Medium Frequency, High Frequency, and Very High-Frequency Transceiver. Due to the increasing traffic in Sunda Strait, DJPL established Merak VTS in 2015. Recently, both of Cigading SROP and Merak VTS are supporting each other functions. In case a vessel is not installing AIS onboard or either the AIS is not working, she must maintain communication by transmitting her information to the SROP.

At present, Merak VTS covers one sector in Sunda Strait area. There are three VTS staff who are responsible for monitoring the 24 hours non-stop operation of Merak VTS, including one VTS supervisor and two VTSOs. There are in total 16 personnel of VTS staff and two personnel of technician (DJPL, 2015).

3.3.3. Traffic situation

There is fluctuation in the shipping activity near the Sunda Strait caused by two main shipping routes which intersected in the middle of the Sunda Strait. A north-south bound international shipping route intersects with the east-west bound national shipping route of the Sunda Strait. The international shipping is transporting commodities between southeast, east, and middle Asia countries to Australia. On the other hand, the national shipping is connecting crossing routes from Port of Merak, Port of Tanjung Priok, Port of Bakauheni and other ports in the district of Banten. Ship traffic density between these routes is likely to grow since the Indonesian Government is speeding up Indonesia maritime development by proposing a sea highway (IMO, 2018).

In 2016, there were 53, 068 ship voyages made through the area of the Sunda Strait or on average 145 ships per day (DJPL, 2018). It is not to mention the daily fleet of domestic ferry solely could reach up to 150 trips during peak season (Sunaryo, Priadi and Tjahjono, 2015).

Meanwhile, the domestic ferry has one trajectory connecting the ferry port of Merak in Java Island and the ferry port of Bakauheni in Sumatera Island, other national and international vessels passing through Sunda Strait or coming to the ports have no exact trajectories. Consequently, these vessels create different patterns varying from 2 nm to 3.9 nm, with around 10 to 30 ships captured on each trajectory per day (see **Figure 3.2**) (Sunaryo, Priadi and Tjahjono, 2015). These crossing and passing vessel traffic pattern creates the potential for a collision with ships passing the Sunda Strait.

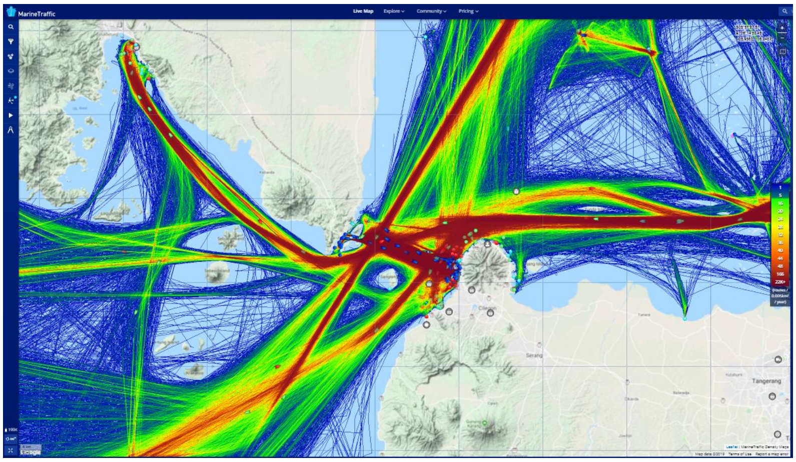

Figure 3.2 Traffic in Sunda Strait
(Source: www.marinetraffic.com, accessed on 3rd July 2019)

The crossing lane intercedes with ASL I, therefore the high potential for ship accident can not be denied. Name the example of accidents in Sunda Strait is the fire in Ro-Ro vessel Ferry Laut Teduh 2 on 28th January 2011 which was resulting severely damaged Ferry, severely injured of 22 persons, and lost 27 lives of its passengers (KNKT, no date). Other case is a collision between Ro-Ro vessel Ferry Bahuga Jaya with gas taker Norgas Chantika on 26th September 2012, which lost six lives of its passengers and one life of ship crews (KNKT, no date). On 3rd May 2014, there was again collision accident of Ro-Ro Ferry Marisa Nusantara and cargo ship Qihang. The accident was resulting in the severely damaged Ferry and lost its 24 carried vehicles (Muslihah, 2014).

According to the released report of the National Transportation Safety Committee (KNKT) in Indonesia, the traffic density is in line with the risk of marine accident or incident. The KNKT is established and assigned to inspect ship accidents. The recommendations post-accident or incident will be issued to prevent the recurrence of similar accidents. In 2009, the released casualties report stated that human error is the main factor of accidents which affecting 52 accidents over 124 marine accidents in total, followed by environmental condition to 41 accidents and technical error to 31 accidents (KNKT, 2009). In addition, analysis of accident in 2003-2008 shows that human error, environmental condition, and technical error is constantly being the cause of accident (Trans Asia Consultants, 2009).

3.3.4. Rules, services, and pilotage

Based on the SOP of Merak VTS attached in the *Keputusan DJPL* (DJPL, 2015), the national guidelines are complying with the international regulations which are IALA VTS Manual, IMO A.857(20), IMO A.851(20), IALA V-119, IALA V-127, IALA V-1045. The SOP consists of VTS purpose and goals, operational area, criteria of mandatory reporting ship, the responsibility of VTS staff, shifting hour of watch, logkeeping, coordination with stakeholders, VTS equipment, routine communication, internal procedure, external procedure, and attachment (DJPL, 2015). Currently, the Merak VTS operates 15 AtoNs.

Merak VTS provides INS to the mariners. The essential information will be available for mariners for onboard navigational decision making on request of mariners, at time of broadcasting, as the ship leaving the port, and when deemed necessary by VTS. The information is weather and tidal information, safe of sailing passage, and present situation of the traffic. VTS also establish coordination to connect mariners with the pilot (DJPL, 2015).

3.3.5. Adoption of ships' routeing

Based on the Resolution MSC. 72(69), three regions of ASL in Indonesia have been adopted by IMO on 19 May 1998. The archipelagic State may designate suitable sea lanes for the continuous and expeditious passage of foreign ships through its archipelagic waters. Meanwhile, all ships enjoy the right of this ASL passage. They shall respect applicable sea lanes and traffic separation schemes established (UNCLOS, 1982).

The proposal of SRS and routing measures by means of TSS with precautionary areas, inshore traffic zone, and areas to be avoided in Sunda Strait area were submitted on IMO's NCSR 5th Session in 2017 (IMO, 2017). The Sub-Committee approved the establishment of TSS, associated routing measures, and precautionary areas with the recommended direction of traffic flow. This proposal was then be forwarded into IMO's MSC 101st session for adoption and expected to be implemented one year after (IMO, 2019a). The MSC 101 session took place on 5-14 June 2019 in London (IMO, 2019b).

3.4. Warnemünde VTS Centre

Ensuring the safety and efficiency of shipping and prevention of hazard for the environment are the responsibility of Directorate General for Waterways and Shipping (GDWS) and the Subordinate Waterways and Shipping Offices (WSA). The Federal Ministry of Transport and Digital Infrastructure (BMVI) has developed together with Federal Waterways and Shipping Administration (WSV) the so-called security concept German coast, which is constantly adapted and updated to the developments in maritime shipping and the needs of the maritime environment. The shipping traffic in the German Bight, parts of the Baltic Sea and waterways to the seaports are continuously monitored by the *Verkehrszentrale (VZ),* or internationally refered as the VTS Center (GDWS, no date).

Germany has 8 VTS Centres across the country, which are Cuxhaven, Bremerhaven, Bremen, Brunsbüttel (Elbe and Kiel Canal), Emden, Travemünde, Warnemünde, and Wilhelmshaven. The Warnemünde VTSC is the organizational unit of WSA Stralsund and has been actively operated by the adoption of *Seeaufgabengesetz* including the traffic regulation, which is *§ 10 Schiffssicherheitsverordnung* and from the *Bundeswasserstraßengesetz.* It is headed by the GDWS and the highest authority is the BMVI. As a sub-authority of the WSV, WSA Stralsund is responsible for the facilities and adjacent waterways in parts of Baltic Sea. In respect to this, the Warnemünde VTS Center handle the assigned tasks together with another subordinate unit, such as the telecommunications and the building department (WSV, no date b).

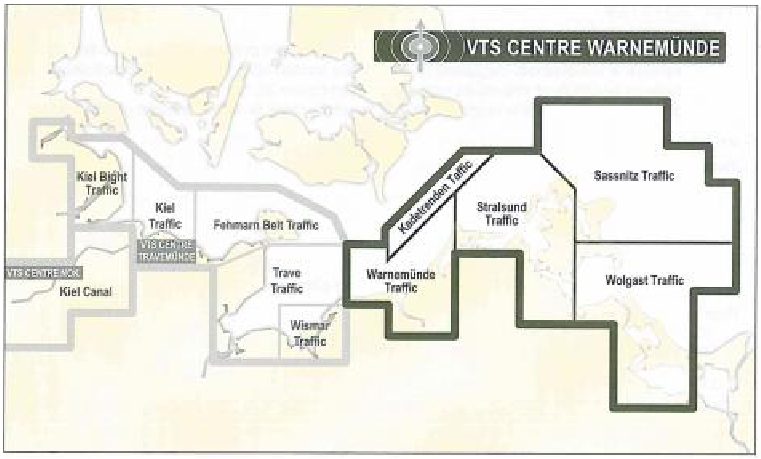

Figure 3.3 Overview Chart of Warnemünde VTSC
(Source: VTS Guide Germany, No. 2011, BSH, 2018)

3.4.1. Environmental condition

The Baltic Sea Area is one of the largest brackish-water area in the world (HELCOM, 2013) with semi-enclosed water exchange into the North Sea through the narrow and shallow Danish Straits (The BACC II Author Team, 2015). In the north, the seabed and coastline are mostly rocky with a labyrinth consists of skerries and islands. Meanwhile, the south and southeast are dominated by sand and gravel with open sandy shores. The entire sea is very shallow, with an average depth about 50 meters (HELCOM, 2016) and more than one third is shallower than 30 meters (HELCOM, 2013).

Half of the sea area is averagely covered with ice during winter. The tidal amplitude in the Baltic Sea is small (The BACC II Author Team, 2015) or practically no tides. However, the sea level could vary significantly during periods with strong winds (HELCOM, 2016).

The temperature trends from 1970 to 2008 showed the significant changes of +0.2 to +0.3 °C per decade during spring and summer in the central and southern parts of the Baltic Sea region (The BACC II Author Team, 2015). The year of 2017 could be classified as a particularly moderate air temperature (Naumann *et al.*, 2018). In winter, the sea ice may be formed, but it had been poor since 1998. The annual mean days with air frost was about 60 frost days, but a significant decrease was observed (Lefebvre and Rosenhagen, 2008).

The wind direction varies in a year and no long-term trends have been detected since the nineteenth century. Kuste (Lefebvre and Rosenhagen, 2008) defined the Baltic Sea coast has a higher percentage of gentle winds (0.3 to 5.4 m/s or Beaufort force 1 to 3) comparing to the moderate winds (5.5 to 10.7 m/s or Beaufort force 4 to 5). The strong wind might be manifested to a Beaufort force 6 and above (Lefebvre and Rosenhagen, 2008).

For the precipitation, there was a tendency of positive trends in winter and spring after half of the twentieth century. The negative trends were detected in summer, and some cases, in autumn (The BACC II Author Team, 2015). The precipitation could occur as snow between 20 to 30 days along the Baltic Sea shore in winter months. The number of thunderstorms is relatively low in the coastal areas (Lefebvre and Rosenhagen, 2008).

For the weather, the sunshine duration was increased from the northern towards southern region of the Baltic Sea. The mean cloud cover showed only little variation ranging from 4 to 6 octa (Lefebvre and Rosenhagen, 2008). Recently, the negative trends in cloudiness have been detected over the decades (The BACC II Author Team, 2015).

For the visibility, it would be limited by the fog and the changing of temperature conditions. The coastal fog and sea fog commonly occurs in late spring when the water surface is colder than the land surface. In the winter months, the fog occurred about 6 to 8 days per month. Meanwhile, it is averagely only once a month in the summer months (Lefebvre and Rosenhagen, 2008).

3.4.2. Historical development

At first, Germany established the first reporting systems only by VHF. The first radar stations were installed for research purposes in Bremerhaven, Cuxhaven, Brusnbüttel, and Hamburg in 1953. Only supported by radar advice in 1955, the passenger vessel "Italia" sailed from Elbe estuary to Hamburg within 10 hours in dense fog. The development was made from 1960 by installing radar chains along the waterways (WSV, no date b).

In October 1990, the WSA Stralsund was founded from parts of the former Maritime Office (SFA) and the former Sea-Hydrographic Service (SHD). The former 460 employees were distributed into three different places, namely Rostok, Stralsund Dänholm, and Stralsund Frankendamm, which made the management enormously difficult. In short, planning of the new building was swiftly initiated by the Schleswig State Construction Office and was finally conducted on May 5, 1995, in the Hanseatic City of Stralsund (WSV, no date b).

The Warnemünde VTS continously monitors five sectors in Baltic Sea in 24 hours a day. These sectors are the Warnemünde/Rostock Traffic, Stralsund Traffic, Wolgast Traffic, Sassnitz Traffic, and Kadetrenden Traffic. There are four out of 25 personnels of VTS staff who are on monitoring duty per shift (WSV, no date b).

3.4.3. Traffic situation

Some of the Baltic Sea areas has the densest maritime traffic in the world, with more than 2,000 ships daily, excluding the ferries, smaller fishing vessels, or leisure crafts (IMO, 2005). As a highly industrialized country for foreign trade and supply of raw materials, maritime shipping is the crucial aspect for the Federal Republic of Germany (Müller, Zölder and Hartmann, 2006).

Around 45,000 ships are entering the ports of Rostock, Stralsund, Wolgast, and Sassnitz in a year (WSV, no date b). The port of Rostock is one of the largest Germany ports on the Baltic Sea coast. It is frequently visited by 190 cruise ships and characterized by ro-ro vessels connecting Scandinavia and Baltic Sea area, pleasure boat, also tourism attraction (GDWS, 2018) p.27. The port of Rostock recorded 7,649 port calls by ferry and ro-ro vessels, tanker, cargo vessels, and cruise ships in 2018, of which 6,034 port calls alone were made by ferry and ro-ro vessels (Rostock Port, no date). The traffic pattern in the Baltic Sea could be seen in **Figure 3.4**.

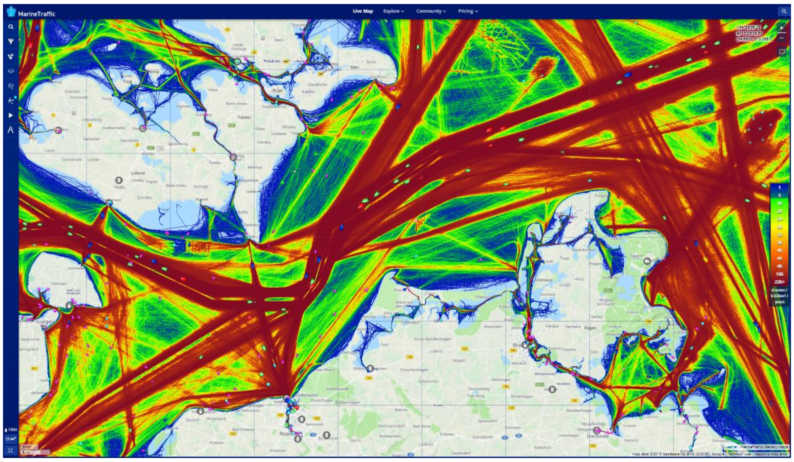

Figure 3.4 Traffic in Baltic Sea
(Source: www.marinetraffic.com, accessed on 3rd July 2019)

From the 296,4 million tonnes of cargo handled in Germany's seaports in 2016, the port of Rostock handled the highest amount of freight traffic in the Baltic Sea area as much as 20,96 million tonnes. The ship traffic in Germany is mostly covered by Ro-Ro ships by 50%, followed by general cargo ships, passenger ships, container ships, tanker, and other vessels (Marinekommando, no date).

According to the statistics by Federal Bureau of Maritime Casualty Investigation of Germany, the Baltic Sea and ports are the areas with the second-highest accident with 39 number of accidents after the Elbe from Cuxhaven to Hamburg, Kiel Canal with 53 accidents (BSU, 2018) p. 32. Referring to the Resolution MSC. 255/84, marine casualty investigation authorities are defined as safety investigation in EU Directive 2009/18 and, respectively, in Germany's Maritime Safety Investigation Law. The investigations aim to improve maritime safety, both during or after accidents.

3.4.4. Rules, services, and pilotage

In order to cover Baltic Sea, Germany published weekly Notices to Mariners (Nfs) and other nautical publications, which are VTS Guide Germany No. 2011, German Traffic Regulations for Navigable Maritime Waterways (SeeSchStrO), and Navigational Warnings (Baltic Sea Hydrographic Commission, no date). The SeeSchStrO consists of general provisions, visual signs and sound signals of vessels, sailing rules, stationary traffic, miscellaneous provisions, competencies, and responsibilities of the WSV, provisions on administrative fines, and competence (BSH, 2017). Currently, WSA Stralsund operates about 1,200 AtoN and 150 fixed maritime signs (WSV, no date a).

Warnemünde VTS Center provides INS in all sectors to report information to mariners. Some sector also provides NAS and TOS to the mariners. The NAS provides advice and alert to shipping which granted by pilots or VTS staff. Meanwhile, the TOS has purpose to prevent the development of dangerous situations by giving instruction and having geographical division such as TSS and enforcing regulations (Baldauf, 2019). The coordination to connect mariners with the district pilotage services available are made for sectors of Warnemünde Traffic and Stralsund Traffic. In addition, the Warnemünde VTS Center, as Maritime Assistance Service, is the point of contact between related authority and to involve in particular situations, such as in the event of an incident involving a ship or a ship need assistance but not necessarily in a distress situation (BSH, 2018).

3.4.5. Adoption of ships' routeing

The Baltic Sea area is surrounded by nine countries, which are Denmark, Germany, Poland, Lithuania, Latvia, Estonia, Russia, Finland, and Sweden. The related coastal countries proposed the designation of Baltic Sea Area as a particularly sensitive sea area (PPSA) to the IMO's Marine Environment Protection Committee in 2005. Since then, the PPSA and APMs have been designated and applied in the Baltic Sea Area.

When an area is approved as a PPSA, specific measures can be used to control the maritime activities in the area such as routing measures, strict application of MARPOL discharge and equipment requirements for ships, and installation of VTS (IMO, no date). The APMs set forth to the PPSA are such as TSS in the Bornholmsgat, TSS in waters north of Rügen, and an inshore traffic zone in the TSS south of Gedser. The inshore traffic zone in South of Gedser and TSS in North of Rügen are located in German sea areas (IMO, 2005).

Since it is adopted, positive outlooks have been seen. There have been no accidents recorded in these areas, except one collision due to human factors near the TSS to the north of Rügen in 2008. Nonetheless, the TSS off Gedser continues to feature a high risk of accidents and resulting spills (Prylipko, 2014).

3.5. Collision Frequency of Risk Assessment

Within the area in which ships are sailing, vessel traffic needs to be monitored and the probability of having risk always exist. By estimating the potential number of risk events and its frequency, the competent authority can take a prevention action in the first place. One of the most popular Risk Assessment Tools that can be used to analyze these data is IALA Waterway Risk Assessment Programme (IWRAP). According to the working document for IWRAP MK II (Friis-Hansen, 2008), collisions can be divided into two types, which are collisions along the route segment, for example is overtaking and head-on collisions; and collisions when two routes cross each other, merge, or intersects each other in turn, for example is crossing.

The procedure for calculation of the number of collision candidates, N_G, for the two types mentioned above is different since the geometric number of collision in the first type becomes dependent on the lateral traffic spread on the route. Meanwhile, the second type is independent of the traffic spread (Friis-Hansen, 2008). This can be seen by comparing **Figure 3.5** and **Figure 3.6**.

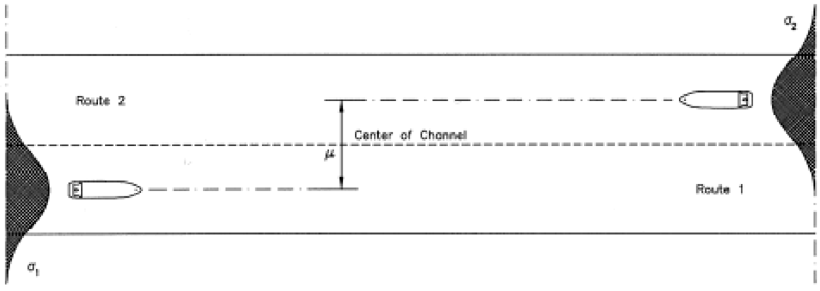

Figure 3.5 Illustration of mean, μ–ratio, and traffic distribution
(Source : IWRAP MK II, 2008)

By analyzing **Figure 3.5**, it can be seen that the probability of the path of two meeting ships will overlap depends on the spreading of the lateral position where the vessels are sailing. When the μ–value becomes larger, the probability of collision becomes smaller. As the collisions might occur along the route, the factor affects the collisions are as follows (Friis-Hansen, 2008):

- The length of the segment;
- The traffic composition, for example the number of passages per time unit for each ship type and size, in each direction, and their speed; and
- The geometrical probability distribution of the lateral traffic spread on the route. The traffic spread is typically defined by a normal distribution but may in principle be of any type. The sign convention for the traffic distribution is measured from the center of the channel and positive towards the right side in the sailing direction.

The distribution of the traffic spread affects the collision frequency of head-on and overtaking, but it does not affect the crossing collisions. For crossing collisions, the frequency depends on the angle between the two lanes. **Figure 3.6** shows the two crossing waterways with the given ship traffic. As illustrated, it can be seen that although the risk area is affected by the spread of the traffic, the frequency of collision is not (Friis-Hansen, 2008).

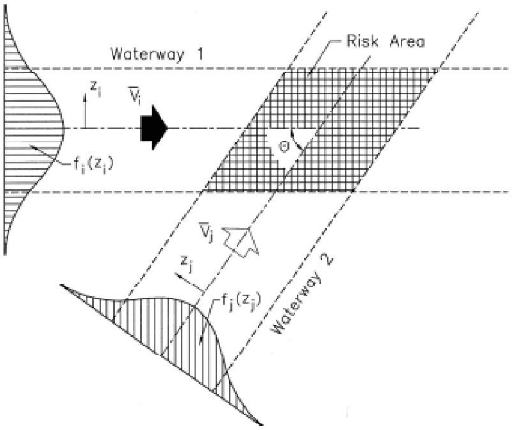

Figure 3.6 Illustration of crossing waterways
(Source : IWRAP MK II, 2008)

The formula used in the iWRAP software to calculate the frequency of head-on collisions are the same with overtaking collision formula. The number of geometric collision candidates for ships sailing along these routes segment (leg) can be expressed as (Friis-Hansen, 2008):

$$N_G^{head-on} = L_w + \sum_{i,j} P_{G\,i,j}^{head-on} \frac{V_{i,j}}{V_i^{(1)} V_j^{(2)}} \left(Q_i^{(1)} Q_j^{(2)}\right) \tag{2.1}$$

Where,

L_w : length of leg

V_i : speed of ship in leg i
V_j : speed of ship in leg j
V_{ij} : relative speed in leg i and leg j
Q_i : number of ship sailing in leg i, based on time, ship type and size
Q_j : number of ship sailing in leg j, based on time, ship type and size
Q_{ij} : probability of ships collision

In the other hand, the formula to calculate frequency of crossing comes as follows (Friis-Hansen, 2008):

$$N_G^{crossing} = \sum_{i,j} \frac{Q_i^{(1)} Q_j^{(2)}}{V_i^{(1)} V_j^{(2)}} D_{ij} V_{ij} \frac{1}{\sin\theta} \quad \text{for} \quad 10° < |\theta| <170° \tag{2.2}$$

$$D_{ij} = \frac{L_i^{(1)} V_j^{(2)} + L_j^{(2)} V_i^{(1)}}{V_{ij}} \sin\theta + B_j^{(2)} \left\{ 1 - \left(\sin\theta \frac{V_i^{(1)}}{V_{ij}} \right)^2 \right\}^{1/2} + B_i^{(2)} \left\{ 1 - \left(\sin\theta \frac{V_j^{(2)}}{V_{ij}} \right)^2 \right\}^{1/2} \tag{2.3}$$

$$V_{ij} = \sqrt{\left(V_i^{(1)}\right)^2 + \left(V_j^{(2)}\right)^2 - 2\, V_i^{(1)} V_j^{(2)} \cos\theta} \tag{2.4}$$

Where,
D_{ij} : geometric diameter of collision between ship (i) and ship (j)
L : length of ship
V : speed of ship
B : breadth of ship
θ : degree of direction of the ship

Assessment of risk accident is significant, where the improvements could be made to reduce risk and enhance safety. For the mariners, despite the years of inspection and training in managing navigation on board, the accidents are still happening, including collision and grounding (The Nautical Institute, 2013, 2019a). Nevertheless, the authority, whereas the ship is sailing into its navigational area, could take action to minimize the risk, for example, establishing an appropriate navigational procedure that can be followed by all vessels. This will lead to a higher level of safe operation when followed by the co-operation and understanding between the ship and the shore in the navigational decision making (The Nautical Institute, 2018).

CHAPTER IV
SURVEY OF COMPLIANCE WITH RULES AND REGULATIONS

According to the guidance from IMO Resolution A.857(20) and IALA Guideline 1111, the rules from these regulations have been listed and benchmarked into the implementation of Merak VTS to monitor the vessel traffic in Sunda Strait.

The rules from each regulations were categorized into three aspects in order to gain preliminary study and to do further study afterwards on the developed essential issues. The defined aspects are explained as below:

a. Technical's aspect, contains all rules from chosen regulations in terms of technology and equipment.
b. Human element's aspect, contains all rules from chosen regulations in terms of staff recruitment, skills, and training.
c. Administrative work's aspect, contains all rules from chosen regulations in the terms of procedures and responsibilities of Competent Authority.

The benchmarking has been accomplished by reading through Standard Operational Procedure of Merak VTS, doing study visits, also doing informal conversational interview with Head of Merak VTS and the experts in the same VTS. The compliance with regulations was done by giving implementation level within three criteria, whether each of the rules has been fully complied, partially complied, or has not been complied at all.

In this preliminary study, the implementation level of IMO Resolution A.857(20) and IALA Guideline 1111 in terms of existing technical, the human element, and administrative work were figured out and verified by an expert. The explanation of rules and regulations compliance are stated below. Nevertheless, the detailed survey is presented in Appendix A.

4.1. Compliance with IMO Resolution A.857(20)

The IMO A.857(20) 'Guidelines for Vessel Traffic Services' is one of the references from IMO that is adopted by Merak VTS on its Standard Operational Procedure (SOP) since 2015. The procedures from SOP of Merak VTS with concern of IMO Resolution A.857(20) are listed as below (IMO, 1997b; DJPL, 2015):

1. Procedure #1: General introduction, goal, purpose, and objectives of Merak VTS;
2. Procedure #1.1.1: The operational coverage area in 1st phase of Merak VTS with information of equipment and provided services; and
3. Procedure #1.1.3: The job description, training, and certification for staff Merak VTS with procedures of monitoring and shift work.

The rules of IMO Resolution A.857(20) mostly covers administrative work and human element aspects of VTS. From the study, some implementations of Merak VTS have fully complied with the rules, which are 50% of all rules in the technical aspect, 55% of all rules in administrative work aspect, and 54% of all rules in human element aspect. Despite the full compliance status, some implementations of Merak VTS have also partially complied with the rules, which resulted in 50% of all rules in the technical aspect, 46% of all rules in administrative work aspect, and 45% of all rules in human element aspect.

Table 4.1 Overview Overview Regulated Rules of IMO Resolution A.857(20)

Technical	Human Element	Administrative Work
- General consideration for VTS	- General consideration for VTS - Objectives and authority - Framework - Prerequisites for the system - System parameters: Recruitment and selection, qualifications, training, certifications	- General consideration for VTS - Guidance for planning and implementing VTS - Determining skill and knowledge requirements associated with VTS functions
(Covered 4% of all rules)	*(Covered 54% of all rules)*	*(Covered 42% of all rules)*

This preliminary study obtained the implementation level to determine the regulations compliance with IMO Resolution A.857(20), which can be visualized through the following graphs below.

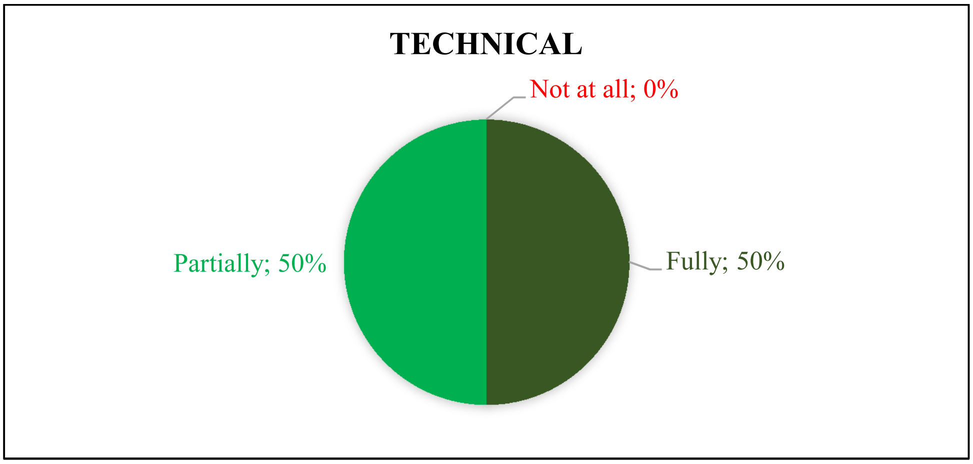

Figure 4.1 Technical Compliance with IMO Resolution A.857(20)

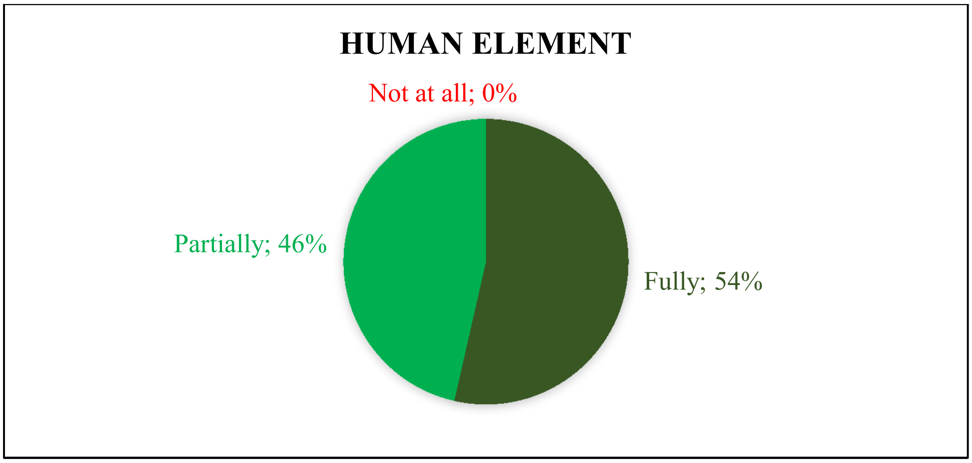

Figure 4.2 Human Element Compliance with IMO Resolution A.857(20)

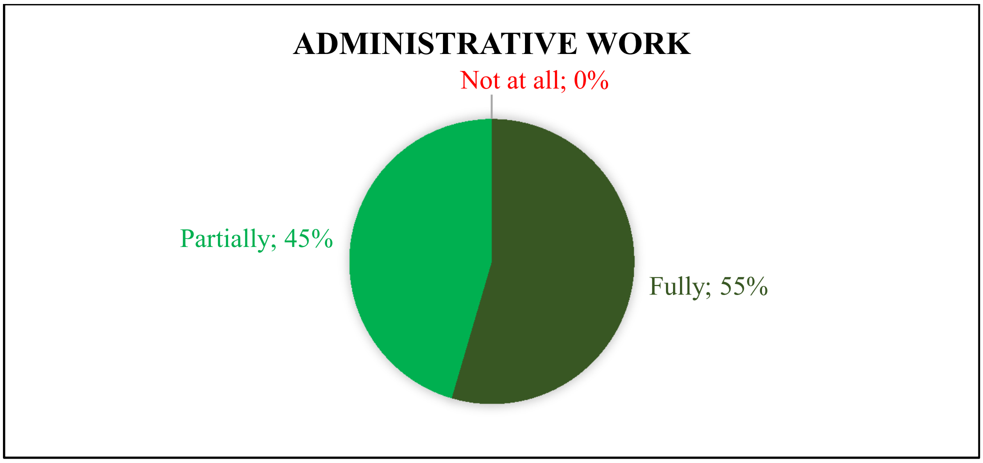

Figure 4.3 Administrative Compliance with IMO Resolution A.857(20)

Note: Score of 100% defines that the particular aspect has been entirely in accordance with *IMO Resolution A.857(20) in this preliminary study.*

4.2. Compliance with IALA Guideline 1111

The IALA Guideline 1111 ‘Preparation of Operational and Technical Performance Requirements for VTS Systems’ has not been mentioned nor adopted by Merak VTS on its SOP. The Ministry of Indonesia adopted the IALA Recommendation V-128 as the standard of equipment for all VTS in Indonesia (Menteri Perhubungan Republik Indonesia, 2011). Nevertheless, this recommendation recognizes and refers to the IALA Guideline 1111 as the updated version and information for VTS systems.

The guideline addresses the relationship between operational and technical performance requirements for VTS equipment. It presents system design, sensors, communications, processing, and acceptance, without inferring priority of VTS equipment (IALA, 2015a).

Table 4.2 Overview Regulated Rules of IALA Guideline 1111

Technical	Human Element	Administrative Work
- Core operational and technical requirements - Radar - AIS - Environmental monitoring - Electro-optical systems - Radio direction finders - Long range sensors - Data processing - VTS Human/Machine Interface - Decision support - External information exchange - Verification and validation *(Covered 92% of all rules)*	- Core operational and technical requirements *(Covered 2% of all rules)*	- Core operational and technical requirements *(Covered 6% of all rules)*

This preliminary study obtained the implementation level to determine the regulations compliance with IALA Guideline 1111, which can be visualized through the following graphs below.

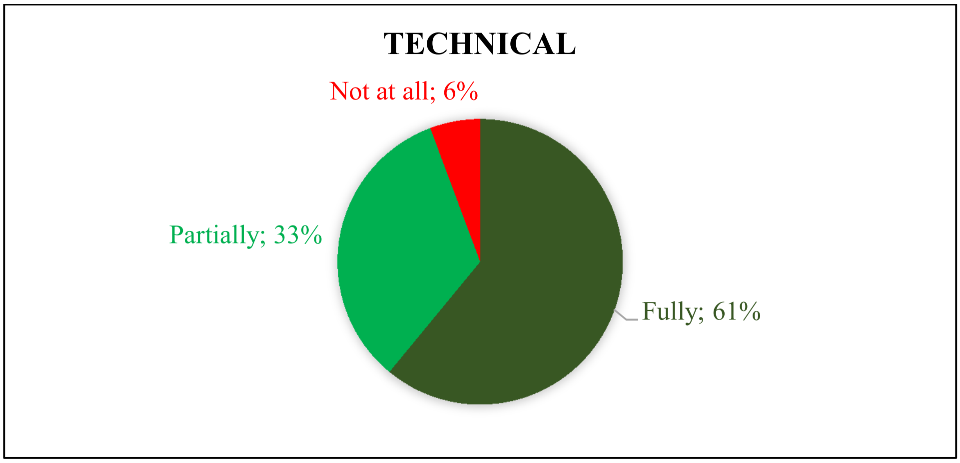

Figure 4.4 Technical Compliance with IALA Guideline 1111

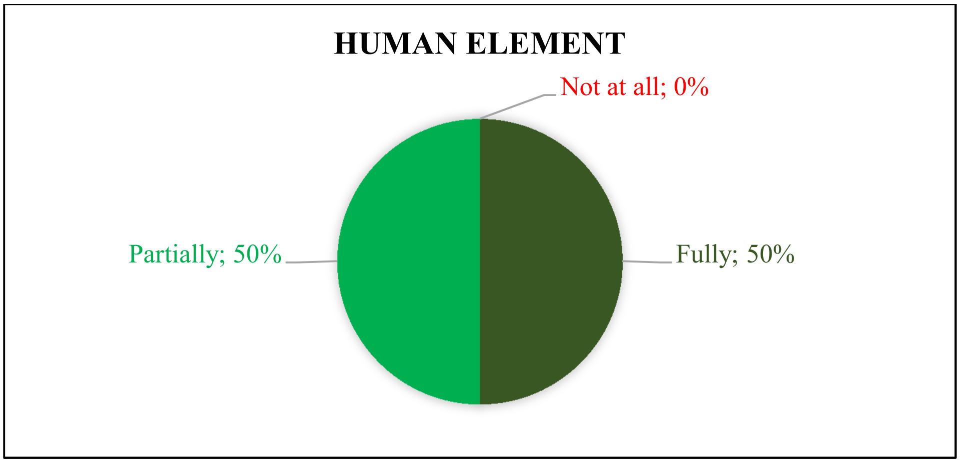

Figure 4.5 Human Element Compliance with IALA Guideline 1111

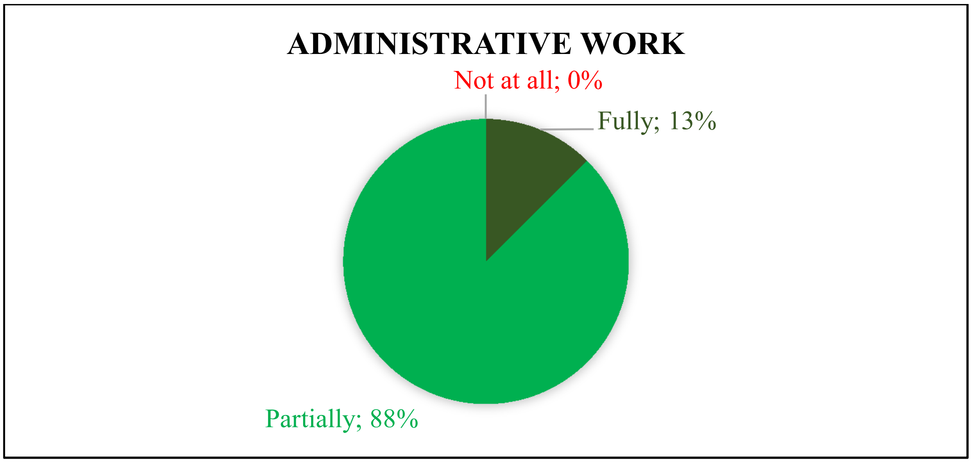

Figure 4.6 Administrative Compliance with IALA Guideline 1111

Note: Score of 100% defines that the particular aspect has been entirely in accordance with IALA Guideline 1111 in this preliminary study.

On the contrary with IMO Resolution A.857(20), the rules of IALA Guideline 1111 take parts in VTS by giving guidance for most of the technical aspects. Only several rules are covered in terms of administrative work and human element aspects. From the study, the graph compliance of the technical aspect in Merak VTS presented several levels of implementation. Most of the implementation of the technical aspect has fully complied with the rules, as much as 61% of compliance. This is followed accordingly by 33% and 6% of the rules has been partially complied and not complied at all. Besides the technical aspect, implementation of administrative work and human element aspect in Merak VTS have 50% and 13% of full compliance with all rules in each aspect accordingly. Despite the lower full compliance compared with another aspect, the aspect of human element has 88% of partial compliance.

Some elements which detected to be not complied with IALA Guideline 1111 are the environmental protection system, long-range identification and tracking (LRIT), satellite-based synthetic aperture radar (SARSAT), few of inter-system data exchange as part of the VTS data management, and track warning for air draught clearance as a function of decision support tools.

The environmental protection system requires the early detection sensors or software processing of the VTS radar signal to detect any pollution incidents that may be caused by visiting vessels. Meanwhile, the LRIT and SARSAT are the long-range sensors for locating or detecting vessels that have not arrived on schedule, arrive unannounced or even in case of an incident. According to IALA Guideline 1111, the tracking function and other data processing functions may need to be considered within the VTS design. Data processing is the collection and extraction of data[1] to provide information[2]. This VTS data management may include information such as voyage data, vessel data, incident data, and equipment fault records. The identified missing elements are the information of the data of berths and capabilities, traffic analysis data, and VTS spares and consumables stock.

The mentioned elements in this preliminary study were found to be not yet installed and were identified as not complying with the rules of IALA Guideline 1111. However, the upgrade and installation of such technical equipment to improve the compliance were on progress.

4.3. Conclusion

The compliance of the three aspects of Merak VTS can be visualized to know the present implementation level of rules and regulations (see **Figure 4.7**).

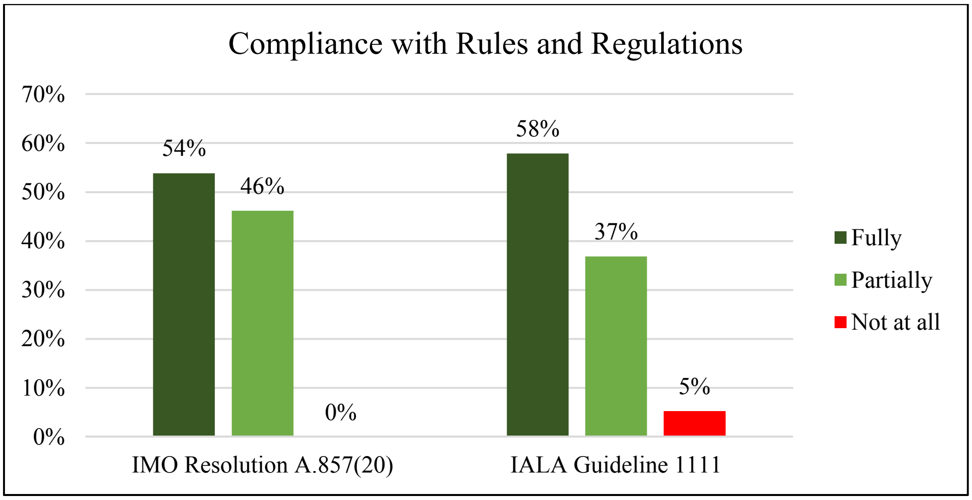

Figure 4.7 Graph of Implementation Level as Compliance with Rules and Regulations

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[1] Is everything that is potentially useful and relevant to the VTS operation (IALA, 2015a).

[2] Is the result of the processing of the input data. It should be appropriately useful and appropriately clear to aid the VTSO, external users, the manual, and automatic decision-making process (IALA, 2015a).

From the graph above, it can be concluded that implementation of rules and regulations for IMO Resolution A.857(20) obtained higher partially compliance status, yet a slightly lower fully compliance status than IALA Guideline 1111.

The present implementation level of Merak VTS considerably complies with IMO Resolution A. 857(20) and IALA Guideline 1111. Nevertheless, IALA Guideline 1111 is not complied by few elements of the technical aspect.

In the further study, human element and administrative work were being focused on having a deeper understanding and on finding potential areas for improvement of VTS. Not to mention, the technical aspect was also being mentioned even though not as detail as the human element and administrative work aspects. The outcome of this study was interpreted in Chapter Five.

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CHAPTER V
DISCUSSIONS

This chapter discusses results from the primary qualitative data collected from interviews conducted via phone calls with experts from the Merak VTS as well as face to face interviews of experts from the Warnemünde VTS Centre and other VTS unit in Germany. The discussion also used secondary data as has been described in Chapter 2.

An empirical study has been carried out to find about the compliance with rules and regulations. According to the preliminary study, Indonesia through the services of Merak VTS has a relative high compliance in the terms of human element and administrative work. However, the technical aspects has been shown to have the lowest compliance compared to others.

This chapter interpretes the preliminary outcome of empirical study and elaborates case study, similarities, and differencies between Merak VTS to cover Sunda Strait area and Warnemünde VTS to cover southern Baltic Sea. The discussion is carried under five themes namely, the implementation level of VTS by compliance with rules and regulations; the training scheme for VTS staff; comparison of the operational procedures in Merak VTS and Warnemünde VTS Centre; usefulness of VTS in ensuring maritime safety, efficiency, and sustainability of maritime traffic; and areas for potential improvement of Merak VTS.

The first theme discusses the three core aspects of rules and regulations governing the system of Merak VTS. It looks at the technical aspects, hardware and software equipment integrated, the coverage area; the human element aspects, personnel operating the facility; and the administrative work aspects, procedures and coordinations. The second theme discusses the recruitment, qualifications and training systems of staff from Merak VTS and Warnemünde VTS Centre. This section looks at the systems and how they can enhance the skills of VTS staff in doing their duties. The third theme, discusses the procedures available for the services of both VTSs. The section identifies particular operation of each VTS to deal with their respective needs, such as environmental condition and traffic situation. The fourth theme discusses the role of Merak VTS and Warnemünde VTS Centre regarding their functions. The section identifies accidents at sea, frequency of risk accident, major contributions of VTS, and the technology in the VTS that can help to avoid the unwanted situations. The fifth theme discusses the potentials of Merak VTS. Based on the discussion preceeding this section, an evaluation of the present situation is possible in relation to the regulations, best practice, and capabilities of VTS to be improved in the future.

5.1. Implementation Level of VTS by Compliance with Rules and Regulations

To help understand the composition of the core aspects of rules and regulations and to add what the has already been discussed in literature about the relevance of Merak VTS, questions on the technical aspects, the human element aspects, and the administrative work of Merak VTS staff were added to the interview guide. On personnel development, the participants were asked the following questions: “how old are you?” “and “what is your background?” All the participants involved in the interview from Merak VTS are between the ages of 21 and 40 and are coming from different backgrounds. Börsch-Supan presented that the productivity on the individual level range from 18 to 65 years old, meanwhile the average work-team age ranges from 25 to 50 years old (Börsch-Supan and Weiss, 2016). The result of study indicates that the personnels at Merak VTS are in productive age and most of them are in the age of average work-team level, which are 21 to 40 years old. Not to mention that the overall share of employment for women in Merak VTS is lower than men (20% vs 80% in 2019). Most of the personnels were coast radio station operators who had worked for one to seven years, while others were ranging from operator of another VTS, software developer, programmer, or new officer who just entering the job following formal education. Almost all of them are civil servant. Nevertheless, there are also a contracted employee at Merak VTS.

5.1.1. Human element aspect

The participants were asked the question: "what kind of trainings have you participated in?" They stated that they had gone through the basic training as VTS operators according to the IALA VTS 103 modules, the communication competency training according to the IMO Standard Marine Communication Phrases (SMCP), as well as the maritime radio communication training of GMDSS's General Operators Certificate according to the IMO.

The personnel who is a contracted employee is recruited and trained purposely to work at the monitoring stations. Unlike the VTS staff who is a civil servant, the contracted employee did not have training on VTS operation as required by IALA and IMO regulations. This is because they are responsible for manning the stations for merely monitoring purposes, but could not intervened with traffic. However, all the participants from Merak VTS had been formally taken through the GMDSS General Operators Certificate for operating all radio equipment during the activities of vessels monitoring.

According to IMO (1997a), "The human element is a compex multi-dimensional issue that affects maritime safety, security and marine environmental protection involving the entire spectrum of human activities performed by ships. Human element plays such a vital role especially in maritime domain. All participants were kindly asked the questions relate to these, such as: "do you believe that you have adequate training to perform your tasks?", "are you experiencing confusion or intense stress at work?", "do you feel like you need to take further course for sharpening your skills and knowledge?", "do you feel tired and sleepy at work?", and "do you believe your working area is safe?". The interviews develop the participant observations to understand each of personnel better.

All the participants stated that the trainings in which they have participated are beneficial and most of them believed they have adequate skills and knowledge to perform their tasks as VTS operator. During on work duties, half of personnel agreed that they are experiencing confusion, especially if emergency navigational situations happened. The grounding, collision, and man overboard are to mention a few. Most of personnel realized that their work is affected by continously growing work pressure. It is to be noted that all of personnel wish to have refresher training or further course for sharpening their skills and knowledge to be performed. Working hours in Merak VTS are mostly in accordance with the operational procedures of Merak VTS (DJPL, 2015), but it could be more than 9 in some ocassions. Nevertheless, feeling of tired and sleepy at work are not the typical conditions of the VTS staff. They stated that they have enough time to take short break during the working hours. However, several personnels strongly agree that their working area is not safe in terms of the location site. The Merak VTS is located close to the sea and therefore received the perceived vibration from vessels. It is surrounded by many power plants and located relatively close to the active Krakatau Volcano. The possibilities of being impacted by accident in the nearer area made some of them not feeling safe at work.

"Once suitably qualified and trained employees are performing on the job, their performance must be observed and monitored to ensure that it continues to meet the established standards" (IMO, 1997b). The participants said that they are likely to be monitored and accompanied during their working hours. Nevertheless, there present structural position of Merak VTS personnel has not fit properly tot the elaborated structure in SOP of Merak VTS. The ideal structure is to have a head of VTS, supervisors, and operators. As substitute of the absence of a VTS supervisor, the senior personnels who have longer experience period in Merak VTS are taking the charge. Therefore, monitoring activities in each shift could still be achieved. Later on, the participants were asked one question: "do you prefer to have more VTS operators available in a team?" All of the participants stated strong agreement regarding this question. They claimed that additional personnels would be very helpful for their monitoring duties, especially when Merak VTS enhances its service to facilitate and support TSS in Sunda Strait.

The interviews found that the Merak VTS operators are trained according to the basic course for navigating vessel traffic through VTS area. All of them are also fully aware that TSS has been adopted and will demand higher skills and attentions from VTS personnel through its implementation in the near future. How this aspect could further be developed to improve the present situations is discussed under traning scheme of VTS staff in proceeding sub-chapter.

5.1.2. Administrative work aspect

When the participants were asked whether there are regulations which Merak VTS authorities are expected to comply? The responses revealed that the Merak VTS is expected to be regulated by requirements of the IMO. The IMO legislations such as in SOLAS Chapter V, regulation 12, guidelines contained in the Resolution A.857(20), MARPOL, and COLREGs. To carry out their duties, the VTS personnels refer to the Standard of Procedures (SOP) of Merak VTS as the operational guide.

The participants of Merak VTS were all able to give a general structure of the nature of vessel traffic in Sunda Strait area. One interviewer said "Merak VTS covers one sector for the entire area of Sunda Strait from Java Island to Sumatera Island." Another participant said that "Merak VTS monitors all vessels, the crossing route for the ferries and passing routes for all vessels. The operation of the ferries has been monitored by the ferries company, namely ASDP Indonesia Ferry. Nevertheless, we keep on the monitoring." The ferries cross the strait and connect port of Merak with port of Bakauheni in a day. Although there is an available VTS near Bakauheni, namely Panjang VTS, communication between the VTSs had rarely been made. The operators monitor and keep watch on Sunda Strait area using the workstations and displays in the monitoring room.

When participants were asked to list government agencies that take benefit from the Merak VTS and the nature of information they received, the stories were mostly the same. All respondents listed the agencies that are written in the SOP of Merak VTS, which are port state control, port company, sea and coast guard, water police, Navy, search and rescue team, port operator and agent, as well as the pilotage. Most of the interviewers agreed that coordination with allied services has been done cooperatively and right in time. One of the participant said “the coordination with government agencies has been continously made. They are always stand by and the coordination with them is important to minimize the consequences of danger, even to prevent such an accident from being happened, through the area of Sunda Strait.”

Core acitivites of Merak VTS is to monitor and inform the traffic. The VTS personnel can not actively organise the traffic and needs to rely on support from other services, such as the pilot service. One participant added, “as its function to provide INS, the only thing we can do is to monitor the sector by maintaining a communication with vessels. Any informations from them then will be delivered to the particular agencies in case of any assistance are needed or any misbehaviour are seen from the vessel.” When there are any non-compliance with VTS regulatory requirements, it seems like no strict enforcement or fine being charged to the particular vessel. Another participant argued that within this condition “we don’t know the specific enforcement applied to the ship. Until now, we have given recommendations if there is misbehaviour of a vessel. When it comes to any worsen condition or urgency, we hand the informations over to the allied services[3]. Nevertheless, we do a follow up communications post accident or incidents to them.”

The interviews revealed that the Merak VTS staff are showing neither high nor low concern about the rules and regulations. Nevertheless, they are aware and operate the system in Sunda Strait in accordance with procedures, rules and regulations from national and international organization such as the SOP from DJPL, the IMO and IALA.

5.1.3. Technical aspect

All the participants from Merak VTS were well vested in basic knowledge about the hardware components of its VTS. Participants were asked two major questions on hardware components during the interview. These include “what are the equipments used to support monitoring and communication of navigation in your area?” and “how frequently do you use them?” The communication devices installed in Merak VTS is VHF radio. The VHF radio are used for communicating with vessels. The sensors include long range camera, radar, and weather station. In addition, the technician stated that the Sunda Strait area is also equipped with radio direction finder. These devices are installed on Merak VTS, Cipala Hill, Tempurung Island, and Cikoneng Lighthouse. All of the devices are always on use by the personnel, except the CCTV which is currently on progress of installation. In addition, the weather forecast is taken daily from Indonesian Weather Forecast (BMKG).

The radar is used for scanning vessels. Particularly, the radar identifies vessel which have their AIS switched off or do not have them installed on board at all. The coverage area of radar in Merak VTS is 48 nautical miles offshore. The advantage of the radar is to constantly detect any objects in the coveraged area in case the AIS onboard the vessel is not active or the vessel has not installed AIS onboard. The Merak VTS also included a GMDSS set. The GMDSS device is used to communicate with vessels via broadcast and on designated channels. The GMDSS receives alerts from vessels in distress so that appropriate action can be taken. The visualization of Merak VTS sector and radar coverage was plotted by blue line and red circle into AutoCAD software on the map of

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[3] Are the activities related to shipping in ports, such as pilotage, inspections, customs, security, etc (IALA, 2016).

Sunda Strait from Hydrography and Oceanography Center, Indonesian Navy (Pushidrosal), presented in **Figure 5.2** Plotting Radar Coverage in Merak VTS. The radar coverage projected is 48 nm and located in Cipala Hill.

Figure 5.1 Actual Electronic Chart Display and Information System in Merak VTS

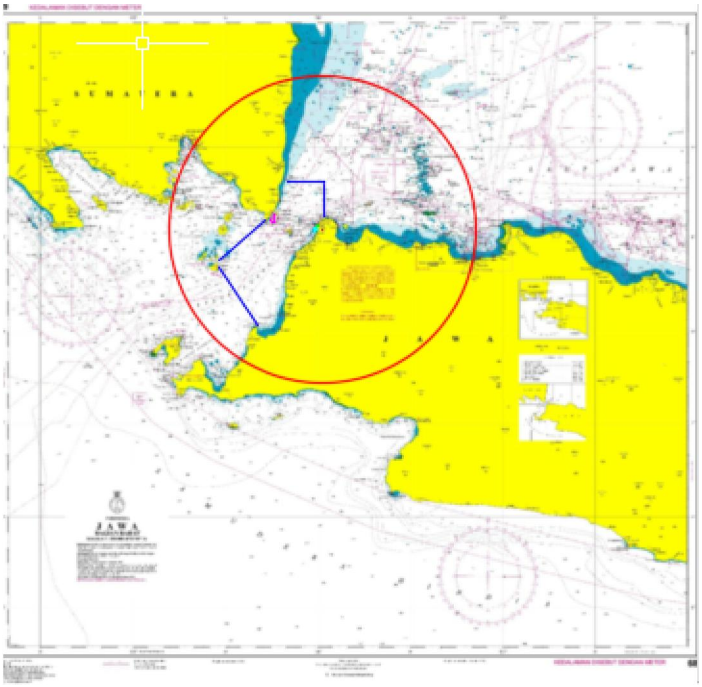

Figure 5.2 Plotting Radar Coverage in Merak VTS
(Source: *Pushidrosal*)

Currently, there are several types of equipment that are planned to be installed for Merak VTS operation. The new types of equipment to be installed are AIS base station, long-range CCTV surveillance, weather sensor, workstation units, VHF radio, and generator. Some of the existing equipment would also be changed or upgraded, such as the VTS software with alert systems, radar, medium-range CCTV surveillance, and power supply. These equipment are intended to repair or maintain the quality of existing equipment and to support the monitoring of new routeing system in Sunda Strait. With all these communication devices and data sensors, Merak VTS has been preparing the technologies and expertise needed to improve its operation.

The interviews revealed that the Merak VTS staff has the basic infrastructure necessary for conducting descent surveillance on safety and maritime security in the Sunda Strait area. In addition, Merak VTS is also prepared in terms of technical aspects to fully support the implementation of TSS in 2020.

5.2. Training Scheme for VTS Staff

The first and third sub-objectives of the study are to get to know the present implementation of Merak VTS and figure out the best practice identified in Warnemünde VTS Center. According to the Resolution A.857(20), the competent authority should specify the level of skill and knowledge a VTS operator must have based on the background and prior experiences, also should consider the training requirements regarding the tasks to be performed.

The qualifications of VTS staff in Indonesia as has been defined in literature are then asked the participants with the following questions: “what is your prior background and position?”, “What is your latest education and training?”, and “how many years have you been working?”.

All participants of Merak VTS do not have have mariners background. They have civil servant background, and most of their position level have passed the applicable minimum qualification when entering the VTS, which is Civil Servant Echelon II/b. The participants have different education background and training. For the formal education background, the criteria is an Indonesian high school degree or equal. All of the participants have a high school or either higher degree, such as diploma degree or bachelor degree. Some of them have taken some basic training to navigation or communication devices before applying themselves as VTS operator, such as GMDSS General Operator Radio’s Certificate (GOC). The participants have a ranging period of experiences in Merak VTS from one to five years. There is also one participant who has already been an operator in another VTS for two years. However, there is a demand to have two years of work experience before entering the field of VTSO. The study found there is a case that personnel directly entered the field after education. Nevertheless, it is compensated by having graduated from higher degree and being accepted as a civil servant.

On the contrary, the Warnemünde VTS set higher qualification for its personnel to become the operator. All of VTS staff have to have mariners background and have experiences sailing on board, ranging from the captain, first officer, to at least was having a position as the deck officer or equivalent. Therefore, the applicant has to show their certificates prior to the recruitment of VTS staff. For becoming an operator, one had to have graduated from a technical college. Meanwhile, one had to have graduated from an university of applied science for becoming an supervisor. The participants have a ranging period of experiences in Warnemünde VTS and also have prior experiences in another VTSs. Moreover, an expert from another VTS in Germany said that he has 27 years of experience as the captain and also the VTS supervisor. The study in Germany shows that the mariner's background is important for any VTS staff. By having this background, one has the intuition to the best practice of operation on board of the ship, what is needed in a specific sit, and how to manage such a situation in the monitored navigational area by the VTS. Therefore, they have the better focus and more goal-objective oriented to achieve the safety of the maritime traffic.

The participants of Merak VTS were furtherly asked to state the training systems during their period as VTSO. All of them had taken GMDSS GOR before becoming the VTSO. Meanwhile, the basic operator training was taken after becoming the VTSO. There are some of participants had participated in maritime english, basic operator, and VTS operator trainings. However, there are more participants who had not taken part in such a training. The Operator Basic Training is in accordance with IALA VTS 103 modules, namely V-103/1. All participants agreed that the training they participated is beneficial for them.

As the training recommended by IMO (1997b), the IALA VTS 103 modules consist of VTS Operators Basic Training (V-103/1), VTS Supervisor Advancement Training (V-103/2), VTS On The Job Training (V-103/3), VTS On The Job Instructor (V-103/4), and VTS Revalidation of Recurent, Adaption, or Updating (V-103/5). Through the interviews, the training system level in Indonesia is quite different from the IALA VTS 103 modules. The training could be provided by the government agency or third party. Most of the time, the training received by Merak VTS operator is part of *BP2TL*[4] program that was established by the Ministry of Research, Technology and Higher Education of Indonesia. The system of training for VTS operator consists of maritime English course, basic VTS course including V-103/1 in V-103/3 altogether for 40 days, and operator VTS course for 40 days. For the On The Job Training, one interviewee of Merak VTS said that this training has never been offered before and the operator basic training has recently deleted from the training programme.

The personnel in Warnemünde VTS were taking part in On The Job Training of V-103/3 and Basic Training of V-103/1 training of IALA 103 modules. To rememorize the knowledge, especially skills in which necessary during unusual operation situations, all of the personnel of Warnemünde VTS also have to participate in the refresher training of V-103/5 for every two years. It is not to mention that they are also participating in Maritime English. In addition, to upgrade a level into the supervisor, one has to take part in Supervisor Advancement Training of V-103/2 in IALA modules.

As in accordance with IMO Resolution (1997b), authorities should be aware of the provided training by considering the prior qualification, skills and knowledge of the VTS staff. Meanwhile, there are some differences in the qualifications of Merak VTS and Warnemünde VTS, they might participate in different types of training to reach an equivalent skills and knowledge. Though, the finding showed training scheme which is not in accordance between the qualification and the training itself. The study found the ideal training scheme of Germany which all of the operator and supervisor of VTS in

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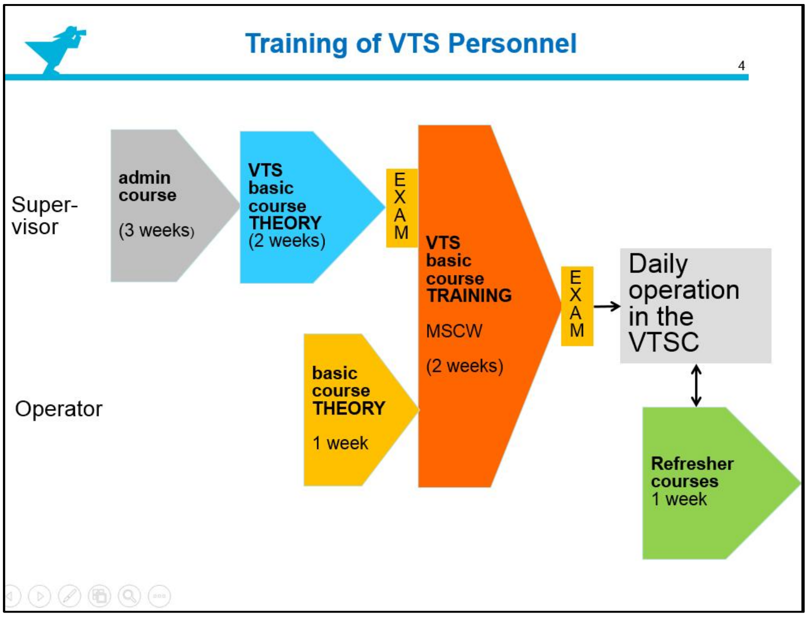
[4] BP2TL stands for *Balai Pendidikan dan Pelatihan Transportasi Laut.*

Germany will have to participate in the training (see **Figure 5.3** Training Scheme of VTS staff in Germany **5.3**).



Training of VTS Personnel

4

Super-
visor

Operator

admin
course
(3 weeks)

VTS
basic
course
THEORY
(2 weeks)

E
X
A
M

basic
course
THEORY
1 week

VTS
basic
course
TRAINING
MSCW
(2 weeks)

E
X
A
M

Daily
operation
in the
VTSC

Refresher
courses
1 week

Figure 5.3 Training Scheme of VTS staff in Germany
(Source: Paper presented at Warnemünde Schiffahrtskolleg 2019)

The interviews in Merak VTS revealed that most of the national criteria regarding background, latest education, and period of experiences had been fulfilled. However, the training requirements of V-103/1 and V-103/2 are still far from compliance. Apparently, the qualifications were just being enacted for Merak VTS. In addition, there is also a long process for taking the training after becoming VTSO. The operator has to come into the selection phase for being one of the candidates or delegates prior to the participation of training. Nevertheless, the participants are all strongly agreed that any opportunities of training, either basic training, refresher training, or any further course, as well as periodic training are significant to sharpen skills and knowledge. In contrast, the Warnemünde VTS has a strict qualification and recruitment process for mariners background. Nevertheless, they are continuously provided with all training requirements of IALA V-103 modules.

5.3. Comparison of the Operational Procedures in Merak VTS and Warnemünde VTS Centre

The first and fourth sub-objectives of the study are to get to know the present implementation of Merak VTS and to figure out what has to be prepared to adapt with the TSS in Sunda Strait. Some of the interview questions were therefore designed to support the study investigated and the procedures taken to deal with the respective needs of each of the VTS, such as complex bathymetry, crossing and passing routes, special area, dangerous area, ice navigation, or sensitive ecosystems in Sunda Strait and Baltic Sea area as having been mentioned and defined in the literature.

One main reason that has been indicated from the development of VTS is to ensure navigational safety. However, maritime safety is far broader than just navigational safety. According to the IALA VTS Manual, a control system that is approved by the competent authority and is properly implemented can ensure the consistently maintained standards to provide safe and effective services. Operational procedures are then defined as an integral part of the verifiable system, which contains all internal and external procedures within a VTS.

However, there is an identification of fundamental difference in the operation between the two VTSs. Meanwhile the internal rules and regulations of Merak VTS is written on its SOP, the operation of Warnemünde VTS laid down in the "Verwaltungsvorschrift VV 24-08" and "Verwaltungsvorschrift VV 24-9". When researching and comparing the two VTS implementations according to these rules and regulations, it became obvious that there is a fundamental difference in the operation of the VTSs. The implementation of Merak VTS, is recently dedicated to provide INS and NAS, meanwhile the Warnemünde VTS provides all the three services of VTS, including TOS, as defined by IMO and IALA. Consequently, operational procedures for pro-active avoidance of accidents, such as collisions and groundings, are not yet included in the SOP of Merak VTS. Moreover, so far, there is no active traffic planning and traffic regulation in terms of active controlling encounters of departing and arriving vessels included in the SOP of Merak VTS. That is why comparing operational procedures can not and will not refer to accident avoidance of VTS. The study of the operational procedures of both VTSs was presented in Appendix D.

Taking the above mentioned into account, this sub-paragraph specifically discusses the outcome of the semi-structured interviews and participating observations. In connection with the first sub-objective, the participants were first asked to state the overall traffic situation of Sunda Strait to be covered by Merak VTS. This was meant to know the concern of VTS staff about the functions and needs in Sunda Strait area. One of the participants called said the traffic as:

> "About 150 to 170 ships are averagely detected for a day. As for today, there are 30 ships recorded in the logbook for sailing in the passing route. We also manage communication with fishing vessels, yachts, and other small vessels as long as their AIS is switched on. Otherwise, all we can do is to keep an eye on her."

Another participant said the interaction with participating vessels is used for:

> "For giving an information in time when the Indonesian Navy is doing training within the particular area, for giving a warning when extreme weather or rough sea situation forecasted, protecting cable or pipeline installed in through the sea. There is also a collaboration with the allied services in identifying, assisting, and rescuing any vessels as requested or when deemed necessary. Basically, the Merak VTS staff keep watch across the maritime area of Sunda Strait to ensure safety."

All of the mentioned statement is the major concern in Sunda Strait. It is also to be noted that the crossing ferries are always monitored with passive communication. Based on the responses, it can be said that generally, the awareness of personnel in the monitoring operation of Merak VTS is high. Fishing activities are monitored and vessels in such areas are adviced to keep away. The statements indicated that the participants were mostly listing what the procedures were being used for. Moreover, the external collaboration with allied services shows a state of involvement and what is being done instead of mere listing what could be done.

The participants of Warnemünde VTS were also interviewed by asking with the same questions. The study shows that participating vessels of Warnemünde VTS and Merak VTS are similar. One difference is the division of sectors in Warnemünde VTS. The VTS is divided into five sectors from the entrance to the port approach to the different berths in the port structure. These five sectors are covered by three operators and one supervisor within four workstation which are Warnemünde Traffic, Stralsund and Kadetrenden Traffic, Sassnitz and Wolgast Traffic, and the central of all the sectors.

Each sector in Warnemünde VTS has their characteristics, such as the existence of ship routeings, which are TSS, precautionary area, inshore traffic zones, and deep water routes, the existence of fairways and channels, and the existence of various ports. In fact, there are also many fisheries, fishing vessels, and small boats in their area. It is not to mention that some special activities also occurred, for example diving operation and existence of a wind farm. These are the main concerns in the Baltic Sea to ensure the intense monitoring for safety, efficiency, and protection of the environment in its navigational area.

The investigation further asked participants of both VTSs to state the present situation of participation from vessels in Sunda Strait and Baltic Sea. According to IALA VTS Manual, the international waters or straits can only have voluntary VTS participation by vessels before any mandatory participation adopted by IMO and established in particular areas, such as a mandatory SRS or Ship Routeing measures. If indeed the TSS and inshore traffic zone would be implemented in Sunda Strait, those areas would be given a certain system level to control the ship traffic and maintain the safety of navigation by having the reporting points. This situation could be answered by the adoption of mandatory TSS and ship routeing measures.

Through the observation study in Warnemünde VTS, the VTS operator always pay attention to the incoming or departing vessels and estimate the approximate distance for them to report to the VTS. It turned out that all of the participating vessels inside the navigational area were reporting themselves with no exception. When a vessel does not report herself to VTS, which is a very rare case, the VTS staff will call her through DSC and eventually she can be contacted. This is in contrast with the response of vessels in Merak VTS area.

The responses revealed that the voluntary SRS is established in Merak VTS. Therefore most of the vessels were seemingly not reporting themselves to the VTS at the reporting point. During the night, however, the participants argued that sometimes the ships are likely to follow the rules to be the first one to establish communication with VTS rather than during the day. Nevertheless, the participants also proved there are some vessels who are reluctant and had never reported anything to VTS during operations in day and night. Regardless of these circumstances, Merak VTS staff establish communication with vessels most of the time.

The interviewees were furtherly asked to explain how the communications have been established and how Merak VTS could deal with such of situation. In the words of one participant, they do so by:

> “When a ship enters the area, we always start to establish communication through the emergency channel, VHF Ch. 16. We inform her to alter the channel and to keep

> a listening watch on the designated channel of Merak VTS which is VHF Ch. 20. Otherwise, to alter into VHF Ch.12 when she needs a pilotage service. Every time any difficulties arise to reach the ship, we try to contact her three times in Ch 16, or DSC, but it is rarely used."

Another participant added the statement as follows:

> "If all attempts to communicate with vessel are failed, we try to contact another vessel around her. Hopefully, it works. We also make a record of such a situation into the daily logbook."

One of the difficulties that have been experienced by the participants is the never-ending notification to the ships regarding the designated channel of Merak VTS. They have to continuously give direction to the participating ship to adjust her channel because most of the ships have not been informed or have no idea about such of services of Merak VTS for Sunda Strait area. There is also no speed limit determined for ships sailing in the area. One interviewer stated, "the speed when entering the strait is around 12 to 15 knot. No limited speed has been regulated, but at least the passing ships establish communication with the crossing ferries".

A participant in Warnemünde VTS stated the opinion about this as follows:

> "It is significant to have a mandatory ship reporting system in a dense traffic situation. The vessels are enforced to comply with the regulations and informing us about their existence. A vessel obeys procedures for the sake of her own safety, as well as another vessel around her."

There is also another opinion from another participant of VTS in Germany accepting the previous statement by:

> "At first, there were around 1,000 ships per month reported to VTS. But then mandatory ships reporting system is applied and afterwards there were 5,000 reported to VTS. For this past years, the VTS can manage around 16,000-17,000 ships in a year including small vessels. The small vessels below 50 meters are not mandatory to do reporting to VTS. But in the record, these vessels voluntarily report to VTS because they also want to ensure their own safety."

As has been stated, the report from vessels to the VTS are not seen as a compulsion, but as the awareness of a vessel to ensure her own safety. To monitor Baltic Sea area, the five sectors have their designated channel, including the emergency procedure. When a vessel does not know the channel of VTS, the VTS staff on duty would inform her through the emergency channel, VHF Ch 16, to alter the channel into the particular one. It is to be noted by all participating vessels that each sector has its regulated speed limit and the VTS can take any further action if it is deemed necessary.

In carrying their duties, the Warnemünde VTS staff were seen to have more attention to the participating vessels than Merak VTS staff because of such conditions. Nevertheless, the display in the VTSs show the tracks of vessels by radar and AIS therefore the operators are able to see and advice vessels. Regular broadcast messages as well as AIS message also enable VTSs to communicate with vessels to ensure the safety of navigation.

The interviews revealed that the Merak VTS and Warnemünde VTS staff had taken appropriate procedures during their duties. However, the Merak VTS has to be more careful due to the fact that the mandatory SRS and TSS are coming into force in 12 months after the approval and adoption of the IMO Committee. To manage the ship traffic, the designated speed limit and the enforcement whenever a problem arises in the reporting area have to be considered. This includes defects, damage, deficiencies, or circumstances that affect normal navigation in the reporting area.

5.4. Usefulness of VTS in Ensuring Maritime Safety, Efficiency, and Sustainability of Maritime Traffic

The first and second sub-objectives are to get to know the present implementation of Merak VTS and to determine the accident frequency in the areas of Sunda Strait and Baltic Sea. There was a need to define the parameters of maritime safety and therefore, maritime accident. The overview of maritime accidents at sea and the possibility of risk accident are figured out in this section. However, the risk accident would be limited to Sunda Strait area. In this study, the maritime accident refers to the presence of investigated accident such as fire, explosion, collision, capsizing, foundering, and grounding from 2007 to 2018 in Indonesia and Germany. The focus is on the role of Merak VTS and Warnemünde VTS Center in reducing the risk of maritime accidents and enhancing maritime safety by the contribution and the technology of each VTS.

Data gathered from the released reports from KNKT (KNKT, no date) showed that there were 101 total accidents between 2007 and 2018 that investigated in Indonesia (see **Table 5.1**). In particular, three accidents were occurred in the Sunda Strait area. The number of accidents was not constantly changing between 2007 to 2013. Nevertheless, it showed a significant increase from 2015 until 2017 reporting 19 accidents at the highest. Based on the type of accident, the accidents which are categorized as other are the fatality on board, the lost of control from ships, and the leaking on board. The foundering accident could be caused by the tilted or leaned ships.

Table 5.1 Investigation Report Year 2007-2018 in Indonesia

Year	Type of Accident							Number accident
	Fire	Explosion	Collision	Capsizing	Foundering	Grounding	Other	
2007	2	1		1			2	6
2008	3			1			1	5
2009	1		1	2				4
2010		1	3	1				5
2011	3		2	1				6
2012		2	2					4
2013	2		2	2				6
2014	2	1	1	2			1	7
2015	4		2	3		2		11
2016	3	1	1	6		1	2	14
2017	9	1	1	1	3	2	2	19
2018	1	1	1	1	4	2	4	14

(Source: KNKT, 2019)

In Germany, the data from the finished investigations of casualties are gathered from Federal Bureau of Maritime Casualty Investigation (BSU, no date) showing 105 total accidents between 2007 and 2015 (see **Table 5.2**). The number of accidents from 2007 to 2016 has been fluctuating, which is furtherly decreased and stabilized in 2017. The highest rate was in 2015 with 28 number of accidents. In particular, six accidents were occurred in the Baltic Sea area. Based on the type of accident, the accidents categorized as 'other' are the combination of ships accidents, for example, fire and engine damage, the occupational accident on board, for example, man overboard or missing crew, the technical failure, for example, water ingress or chemical reaction in the cargo, the spillage and stranding.

Table 5.2 Investigated Report Year 2007-2018 in Germany

Year	Type of Accident							Number accident
	Fire	Explosion	Collision	Capsizing	Foundering	Grounding	Other	
2007			1			2	9	12
2008			8			3	8	19
2009			9	2		1	6	18
2010	2		7		1	2	4	16
2011			4			2	4	10
2012			1			2	4	7
2013	3		6		3	1	3	16
2014		1	9		3	1	6	20
2015	5		7		3	2	11	28
2016	2		3		2	2	4	13
2017			2			2	1	5
2018				1			2	3

(Source: BSU, 2019)

The study has the initial objective to calculate the frequency of accident in case of head-on, overtaking, and crossing situations with iWRAP software and has been processing the recapitulation of 365 days traffic in 2017 from Merak VTS and ASDP Ferry Company. It turned out that the analysis has been made in the same year and recently published by IMO for Sunda Strait. The following section only elaborates the assessment of iWRAP before reveals the result.

To quantify the risk accident, the probabilities and consequences involved with the vessel traffic have to be analyzed and assessed. Moreover, the risk analysis has to developed the system knowledge prior to the assessment. First, the configuration of the navigational area is important to consider the area and identify difficulties of the route, which are the navigational routes, such as precautionary area and TSS, the navigational marking, the VTS system, and the pilotage on board. The second one is the composition of ship traffic ranging from the traditional sailing ships to the large tankers. Other important knowledge to be included are environmental conditions and configuration of the considered vessel. The weather condition, wind and current variations, waves, visibility, and ice conditions influence on faults at the considered location. The type, size, speed, pattern, and frequency of the vessels operating in the area also should be registered to forecast the traffic intensity (Friis-Hansen, 2008).

The study identified there was no present navigational route at the time of research. The navigational marking of public AtoNs from DJPL and private AtoNs for ferries from ASDP Company have been identified. The area is covered by one VTS, namely the Merak VTS, and is assisted by the presence of a pilot on board for any required vessels. The channel condition with crossing and passing lanes of vessels are defined. The composition of ship traffic focuses on commercial traffic since it represents the primary threat to the navigational area. The study obtained the fleet data containing the composition of ship traffic from the recorded AIS, as well as the fleet of ferries from ASDP Company. The data then furtherly equipped with the configuration of the considered vessel by information from an AIS data provider, namely MarineTraffic. Eventually, all parameters to model the iWRAP are collected.

The recapitulated data in 2017 showed 47,575 vessels sailing in the Sunda Strait area. As defined in the literature, the distribution of traffic spread has to be considered to calculate the frequency of collisions. The study created scenario and divided the area into 5 paths, which are crossing lane of Bakauheni or Merak to the central route showing 39,605 vessels, passing lane from northern bound Java Sea to the central route showing 3,997 vessels, passing lane from southern bound Indian Ocean to the central route showing 1,846 vessels, irregular lane from Sunda Strait to Java Sea showing 1,956 vessels, and irregular lane from Sunda Strait to the Indian Ocean showing 171 vessels. The TSS entering into force in 2020 is located near the Bakauheni area. It is to be noted, that the routeing system, such as TSS, is applied on the highest frequency of collisions or grounding and is considering the metocean data, the bathymetry data, the conservation area and the port's data.

Based on the proposal of TSS in Sunda Strait to IMO in 2017 , the results of IWRAP simulation showed the total frequency of ship collision as a projection of 2% yearly increasing rate until 2037 is 0.145548 (IMO, 2017). The annual frequency of ship collision for head-on, crossing, and overtaking can be seen in **Table 5.3** Result of Collision Frequency.

Table 5.3 Result of Collision Frequency

Collision Type	Annual Frequency
Head-on collision	0.0158828
Crossing collision	0.0413868
Overtaking collision	0.0141225
Bend collision	0.0475738
Merging collision	0.0226500
Total annual frequency	**0.1455480**

(Source: IMO, 2017)

The Merak VTS has to provide the ships with the information necessary for safe and navigation in the reporting area as required in mandatory SRS. It is also one of three VTSs in the western part of Indonesia which is able to reach the AIS signal from ships located in the area. As one of the configurations of the navigational area in Sunda Strait, the participants of Merak VTS were asked to give an opinion regarding what

contributions have been made by Merak VTS to Sunda Strait area based on their experiences since they started as an operator.
Almost all participants have ever experienced where a collision or dangerous encounter situation happened in the area. Although only half of the participants were satisfied with the implementation of Merak VTS, the interviewees showed the strong contributions of Merak VTS to Sunda Strait area. The major contribution that has been seen in Sunda Strait is fewer casualties, such as man overboard or dying at sea. A collision with a buoy can not be denied for mariners, even in clear weather. The presence of weather services would give significant help for mariners in taking control of their safe voyage (The Nautical Institute, 2019b). Some participants agreed that the presence of VTS could give particular information and so less contact with navigational markings, such as offshore or fixed objects at sea, is achieved. A participant said, "For me, the major contribution of Merak VTS is to lessen the casualties and collisions. Co-ordination with allied services plays an important role to cope and quickly respond to such situations. Together we can also achieve more effective operation, such as for pilotage, anchorage or activities related to the port."

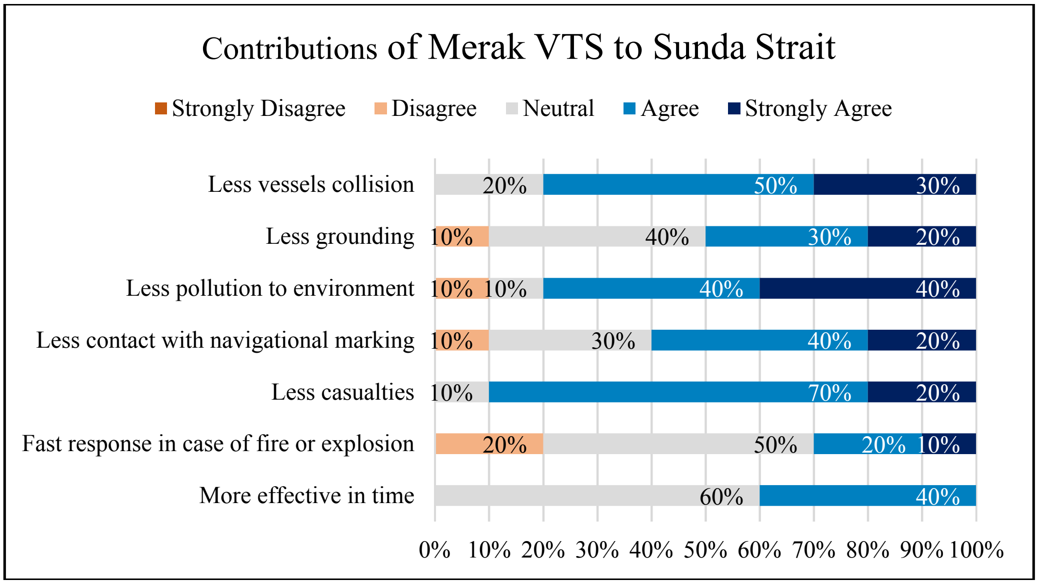


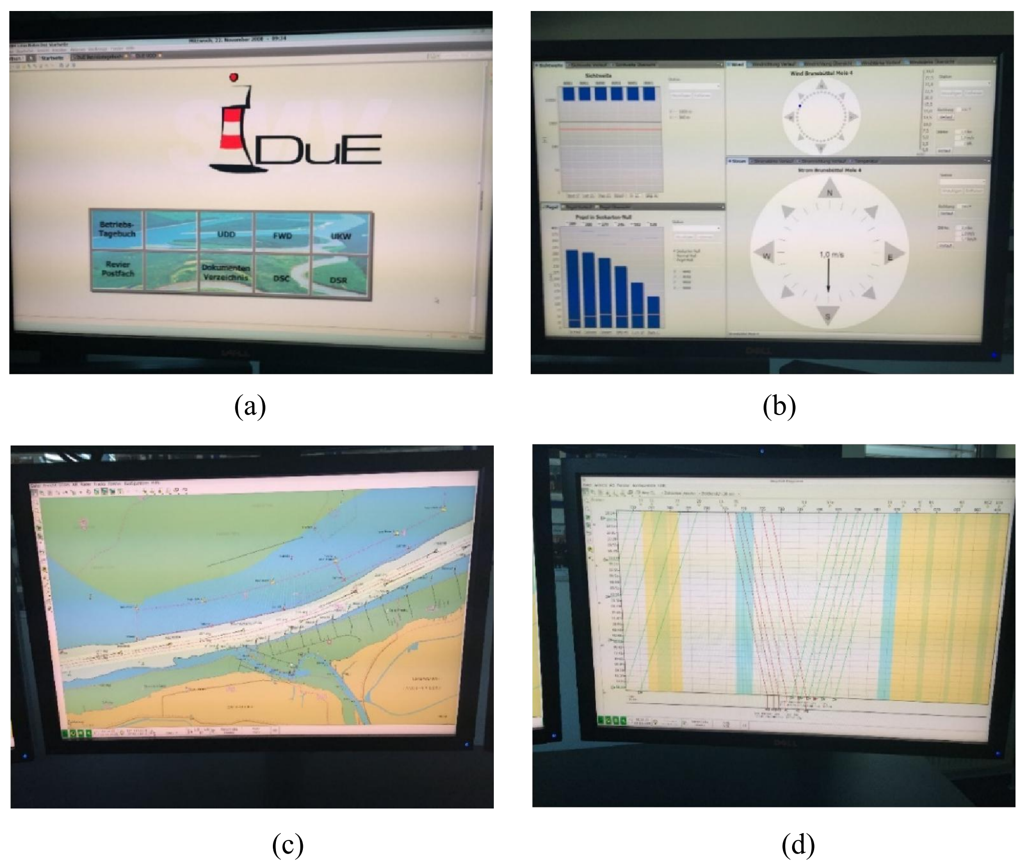
Figure 5.4 Participant's Opinion on Contributions of Merak VTS

At different times, the participants of Warnemünde VTS were also asked the contribution of its VTS to the Baltic Sea area. They were hard to say the accidents that happened in the area. The existence of Warnemünde VTS has strongly corresponded with the function of VTS described by IMO which is to ensure the safety and efficiency of maritime traffic and the protection of the marine environment. As one of its responsibility, the VTS staff will inform hourly traffic situation to the mariners through the designated channel in each sector, consists of the meteorological situations, the visibility, the tidal information, and any other general or developing traffic situations occurred in the area. A statement from the participant in another VTS in Germany, where 1,000 ships are reported to the VTS in a month, added that:

> "I remember two last accidents of fire or explosion which are occurred on one year ago and eight years ago. For the grounding, there were also two accidents reported. They are within this past thirty years. There are almost no collisions happening now."

There is a strong relationship between the technology used in the VTS with the ease operational by personnel to ensure the safety of navigation. The technologies that combat the unwanted situations are such as a broader range coverage of land-based radar to reach long-distance vessels as well as in rough weather and distress, more Aid to Navigations as navigational marking in accordance with the need of the certain area, an advanced system of VTS software to provide alarms or warnings management.

The study observed the provided facilities in the VTS Simulator Room during study visit in the simulation center of MSCW. The work stations to support the monitoring and communication consists of traffic information display, path-time diagram, environmental panel display showing the visibility, tidal, wind, and storm, also the admission panel display.



(a) (b)

(c) (d)

Figure 5.5 The VTS Workstation Displays in the MSCW
(a) Admission panel; (b) Environment panel; (c) Traffic information; (d) Path-time diagram

In the Warnemünde VTS, the traffic situation is monitored by having radar information and display systems, VHF radio communication including DSC, AIS information and display systems, electronic and paper charts, water-depth sounding charts, navigational lights controlling systems, normal telephone and Information Technology systems. Meanwhile, the present equipment of Merak VTS has been mentioned in the sub-chapter 5.1.3 of technical aspects.

For Warnemünde VTS, the existence of AIS and radar are the significant component for the VTS operation. For Merak VTS, one respondent added, that it is also needed: "to have a good internet connection that can support all operation in 24 hours. There was a time when the equipment turned blackout because of the error internet connection. The existence of CCTVs in a certain distance along the area to monitor the vessels is also important." In addition, well-equipped communication devices are necessary to facilitate services.

5.5. Areas for Potential Improvement of Merak VTS

There are many advantages and contributions of the Merak VTS in Sunda Strait. However, the system could be upgraded further to increase its usability. This includes the regulations, best practice of Warnemünde VTS and capabilities of Merak VTS to be improved. In connection with the first sub-objective, the third sub-objective is to identify the gaps of implementation level and derive recommendations to Merak VTS. Participants were asked to list the shortfalls in the use of VTS equipment. They were also asked about their opinions on how these shortfalls could be removed.

Participants noted that, the Merak VTS system basically monitor and report and that it lacks the power to enforce regulations. Instead of eight message markers defined in SMCP, most of the information communicated to vessels are provided with soft message markers such as "information" or "advice." Sunda Strait has coast guard, the Navy, and Search and Rescue units to be informed to assist the vessel in need. However, there is no clear prejudice about what could be called as violating behavior to national and international regulations. In addition, there is no speed limit regulated to the vessels. The participants mostly give a recommendation to the vessel in case of unusual activity detected. Therefore the Merak VTS lacks the power to enforce and to sanction the offenders.

A follow-up questions on the potentials of the Merak VTS as a monitoring tool revealed that the separation of enforcement unit from monitoring system also prolongs responses to incidents. The Merak VTS takes reactive action, such as start to remind the ship after being informed by the allied services which see the unusual behavior from the vessels. In addition, Merak VTS has not informed the further progress of the unusual behavior, except the allied services asked to do further communication with vessels or the incident takes quite a long time to be completed. However, almost all the interviewees stated that the co-ordination with allied services has been well achieved and shown positive results to ensure the safety of the area.

Regarding the coordination in VTS, the Warnemünde VTS has one different party. There is a headquarter of command consisting of Navy to be in charge in a time of emergency for all Germany coasts, namely Central Command Maritime Authority. Besides, VTS in Germany is also mainly in contact with water police and tugboat for controlling the traffic situation. Nevertheless, a participant of Warnemünde VTS added that they are trying to not involve too much to the mariner's operation. He added, "our foremost contributions are to give information, then to give support if deemed necessary, then the final case is to give force." When the final case happens, the VTS will do coordination with the related Allied Services to ensure the safety of its navigational area.

One of the participants from Warnemünde VTS stated that:

> "There are two significant factors to optimize the operation of VTS. The first one is what kind of seaman to handle the operation. A foreman or a student who study by themselves? It is a big point. The second is the equipment which is Radar and AIS which is even able to detect small vessels."

The personnel has an important role in the implementation of VTS. They are the one who will monitor, instruct, and manage the coordination with other parties in time of need. Personnel of other VTS unit in Germany argued that:

> "During operational, such things outside normal situation might have happened and the operator has to make a quick decision based on those situations. Therefore, the experiences as a mariner are one of the significant tools. Becoming an operator required the skill of mariner background."

The study identified the present training of personnel in Germany. First, the personnel will have one year contract and trained by the Authority to get their first training. This basic training is last for eight weeks consisting of three weeks of basic training about the authority, four weeks to do theoretical training, and practical training. A participant from Warnemünde VTS also added that the personnel is facilitated to get on board in a short time with their vessel in order to familiarize themselves with their navigational area. When they are passed the training for over this one year, they can officially be the VTS operator.

According to Praetorius (2014), the number of VTSOs assigned depends on the size of the area, volume, density of traffic, and the geographic conditions. Meanwhile the Merak VTS assigns 3 VTS staff in a shift of 11 VTS staff in total, the Warnemünde VTS assigns 4 VTS staff in one shift of 24 VTS staff in total. The study identified that the VTSs in Germany typically assign 4 VTS staff in a shift consisting of three VTSO and one VTS supervisor. If a VTS implements three shifts to monitor the 24 hours operation, one participant of Warnemünde VTS projected that it is necessary to have as minimum as 16 VTS staff for the total operation. This number is considering the days off and unpredictable situations, such as sickness.

As has been mentioned, another potential for improvement is the coverage ranges of the sensor equipment. The coverage areas of equipment such as the land-based Radar and AIS are currently 48NM and 30 to 200NM respectively. These could be extended by installing and integrating the equipment on patrol boats.

One participant of Merak VTS stated that:

> "If the VHF radio could be extended to reach longer nautical miles, it would be possible for us to maintain communication with another VTS center, which is Panjang VTS. We rarely do communication with them, but if it is needed, we start the communication through a private communication device."

There is an exchange of information and data sharing among VTS and relevant allied services. Therefore, government agencies can take a plan or further action based on the data from the VTS. However, a major potential in Merak VTS is lack of power to enforce the regulation. Another potential is the coverage range of the sensor equipment. The coverage areas could be extended, especially in rough weather conditions. The other potential is related to the recruitments, qualifications, and training of VTS staff. It was also revealed, closer collaboration among government agencies would enhance the effectiveness of monitoring and reporting. Therefore, the usefulness of the system would be improved.

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CHAPTER VI
CONCLUSION AND OUTLOOK

This section summarizes all the important findings, conclusions of the study, and recommendations derived from its results and conclusions. The research was to perform a comparative case study for Merak VTS in Sunda Strait and Warnemünde VTS in the Baltic Sea. The objective was set out to know the present implementation level of Merak VTS in compliance with IMO and IALA regulations, determine the accident frequency of Sunda Strait and Baltic Sea, identify gaps, identify potential areas for improvement of VTS operation to enhance the contributions for safety of navigation, and derive recommendations to Merak VTS.

For this purpose, empirical studies have been carried out by applying qualitative and some quantitative research methods. The research included literature surveys, participating observations and expert interviews mainly.

Participants were drawn from the Merak VTS, the Warnemünde VTS, and other VTS unit in Germany for observations and interviews. The discussions provided in the previous chapter were based on the responses of the participants to the interview questions. The data were discussed following the sub-objectives of the study. The aims of the study were fulfilled beside the analysis of risk accident.The rest of the chapter presents the findings and suggests some recommendations for policymakers and other researchers.

6.1. Major Findings

From the discussion of the qualitative data collected and reviews of the secondary data from the Merak VTS, BSH, IMO, and IALA regulations in relation to VTS operation, the following findings were revealed:

1. The study revealed that the implementation level of Merak VTS in terms of human element aspects and administrative works aspects are having high compliance with IMO Resolution A.857(20). However, the technical aspects showed rather low compliance with IALA Guideline 1111.
2. The investigated traffic and accident situations in Sunda Strait and southern Baltic Sea revealed that both of the areas have dense vessel traffic and have a relative high risk of accidents. Both the areas are having concern on their navigational area and have enforced or in progress of enforcing the systems following IMO. This includes PPSA, TSS, precautionary area, inshore traffic zone, and mandatory ship reporting system for the southern Baltic Sea and TSS, precautionary area, inshore traffic zone, and mandatory ship reporting system for the Sunda Strait.
3. The study revealed that the provided services are in accordance with the need of each navigational area of VTS. The Warnemünde VTS provides INS, NAS, and TOS; meanwhile, the Merak VTS provides INS at present.
4. The Merak VTS contributes to the increase safety level by reducing collisions and grounding accidents as well as other casualties with physical contact with objects at sea, as well as more effective of time and fast response in case of fire or explosion.

5. The study revealed that Merak VTS were trained according to IALA VTS 103 modules, but it has not been fully obtained by all employees yet. The period of trainings as have been provided by Warnemünde VTS are significantly increasing the skills and knowledge of personnel.
6. It was revealed that at present state in Merak VTS, there is some lack of power to enforce regulation effectively and can be enhanced.
7. It was also revealed the expansion in the range and coverage area of the equipment is necessary for better and wider monitoring and reporting.
8. The study revealed that the additional number of staff and closer collaboration among government agencies will probably expand the usability in enhancing effective monitoring and reporting in the Sunda Strait area, especially when a new system such as TSS and mandatory reporting system are coming into force.

6.2. Recommendations

The following recommendations are derived as suggestions based on the findings and conclusions of the research. None of these recommendations are meant as criticism but intended to contribute to potential improvement of existing VTS operation. It is very well recognized that the comparison is made between a long-term operating VTS (in Warnemünde) which has undergone several phases of optimization during its course of existence. In comparison to this, Merak VTS is at an earlier stage of operation.

Again, with the above mentioned in mind, the recommendations are derived on the basis of the research carried out so far:

1. The responses indicated that several staffs were only taken through GMDSS General Operator's Certificate. It is assumed that extensive OJT is to provide skills and knowledge to those operators. The study would like to recommend that all staffs should be trained with IALA VTS 103 course so that they can fully appreciate and understand the procedures and data received, as well as to overcome emergency situations in the navigational area. It is to be noted that not only the basic training, but also the OJT and the Refresher training are also significant to ensure the continued maintenance of a VTS staff qualification. A system similar to the established system may help to further develop and improve the operation of Merak VTS and result in a further contribution to maritime safety.
2. Regarding the traffic composition in Sunda Straits and especially the crossing ferry routes it seems to be that integrated collaboration of VTS and with ferry Companies may utilize the system of monitoring and communication, not only to manage the traffic and the vessels in the time of accidents, but also to take prior action in preventing potential accidents from happening and maybe even contribute to efficient traffic flow without delays and supporting navigation regimes that minimize emissions from ships.
3. For future developments, a higher level of services from Merak VTS seems to be possible and is recommended. Since TSS and mandatory ship reporting system have been adopted by IMO, upgrading the services into NAS and TOS would greatly support the system's implementation.
4. Although the Merak VTS is used to monitor and report the vessel traffic and other relevant information, it is recommended for mariners in accordance to

SOLAS requirements to communicate sufficient information to the VTS, especially in time of distress, to enable prompt assistance to be provided.

5. IMO regulations mandate the vessels to comply with regulations of VTS areas that are recognized by IMO. Therefore, it is suggested the Merak VTS shall take action to contribute to more strictly enforce navigational regulations in Sunda Strait area. Enforcing regulation is one of the best practice to create a deterrent effect for the offenders to ensure safe and efficient vessel traffic in the future.
6. The study further recommends more regular communication between adjacent VTSs, such as Merak VTS with Panjang VTS, to significantly increase monitoring and reporting across the area. The distribution of information is also recommended to be done, for example, the automatically integrated database between adjacent VTSs or even all VTSs in Indonesia.
7. The research has shown, that the technical equipment provides already enhanced monitoring function, e.g., for triggering warning for potential collisions or groundings. Extending the services and training of staff how to make use of such functions efficiently may also contribute to improve future VTS operation of Merak VTS and increase maritime safety.
8. The study also recommends further research and follow-up studies. Such research shall apply other research methods to further investigate accident frequency within the area including, e.g., the projection of safe speed limit as well as a formal safety assessment to asses in more detail the risk and evaluate cost and benefits in reducing the risks.
9. Further research by the DJPL and the District Navigation Class I Tanjung Priok are seemingly recommended as well in the area of operations to understand how successful the implementation of TSS and mandatory ship reporting system can be after coming into force.
10. Last but not least, the study recommends further assessment for the human element aspects in Merak VTS. Compared to the sophisticated training system established at the reference VTS, it seems that planning and establishing systematic training and education for all categories of VTS operators will be beneficial for all the involved parties, which are VTS operators, domestic and international ships as well as waterway and shipping administrations. From the responses, it might also be beneficial to have additional employment of Merak VTS staff, especially the VTS operator, to increase productivity and provide a better working environment. The higher employment also has to be in line with the appropriate training provided for the operator doing the required tasks.
11. Finally, the study recommends the DJPL to continuously update all necessary information to mariners applying e-Navigation concepts, especially for the electronic version of nautical publications related to navigational areas in Indonesia. It could be in part or a whole “VTS Guide Indonesia”, by the gradually accessed information from online or web-based publications, or also by providing information in World VTS Guide. These seem to be significant to ensure the crew on board are familiarized with the procedures and regulations in a particular area.

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APPENDIX

APPENDIX A: Compliance Survey of Merak VTS
APPENDIX B: Participants Consent Form
APPENDIX C: Questionnaire
APPENDIX D: Operational Procedures
APPENDIX E: IWRAP of Sunda Strait

(Appendixes are provided on the attached CD)

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APPENDIX A: Compliance Survey of Merak VTS

In order to analyze the existing condition of Merak VTS, this study took reference from two main guidelines and one supporting guideline, as follows:

1. IMO Resolution A.857 (20) “Guideline for Vessel Traffic Services” (27. Nov 1997), as the main guideline.
2. IALA Guideline 1111 Edition 1.0 “Preparation of Operational and Technical Performance Requirements for VTS Systems” (May 2015), as the main guideline.
3. IALA VTS Manual Edition 6 (2016), as the supporting guideline.

After listing down all requirements based on the guidelines, all requirements are categorized into three terms, which are ‘technical’, ‘human element’, and ‘administrative work’. These categories are defined and can be explained as follows:

a. ‘Technical’, contains all rules from chosen regulations in terms of technology and equipment.
b. ‘Human Element’, contains all rules from chosen regulations in terms of staff recruitment, skills, and training.
c. ‘Administrative Work’, contains all rules from chosen regulations in terms of procedures and responsibilities of Competent Authority.

At first, the Implementation Status is given based on current findings and assumptions whether the requirements have been complied (Yes) or have not been complied (No). The findings are based on the SOP of Merak VTS, study visits, informal conversational interview, and archive documents of Merak VTS equipment. At the later stage, the categorizes will be narrowed down according to the research need and to be confirmed by the Experts through scanning through the drafted results, interviews, or discussions.

1. IMO Resolution A.857 (20) “Guideline for Vessel Traffic Services”

This Resolution describes the principles and general provisions for the operation of a VTS and participating vessels. Contracting Governments should take account of these guidelines when planning, implementing, and operating vessel traffic services. Requirements based on IMO Resolution A.857(20) has three categories, which are Technical, Human Element, and Administrative Work’s Aspects. The descriptions are elaborated inside the tables, as shown below.

Technical’s Aspects

General Consideration for VTS		Yes		No	Existing Condition
		Fully	Partially	Not at all	
Responsibilities and Liability					
In planning and establishing a VTS, the Contracting Government or Governments or the competent authority should:					
1	establish appropriate standards for shore- and offshore-based equipment.	✓			The standard of equipment has been set and written in the #1.1.1 and #2.2.1 SOP of Merak VTS.

2	ensure that the VTS authority is provided with the equipment and facilities necessary to effectively accomplish the objectives of the VTS.		✓		Most of the equipment is already installed according to the standards. However, some of them are not in great conditions, which need improvement or periodic maintenance. Recently, new installations of facilities have been in progress.

Human Element's Aspects

- Annex 1

General Consideration for VTS		Yes		No	Existing Condition
		Fully	Partially	Not at all	
Responsibilities and Liability					
In planning and establishing a VTS, the Contracting Government or Governments or the competent authority should:					
1	ensure that the VTS authority is provided with sufficient staff, appropriately qualified, suitably trained and capable of performing the tasks required, taking into consideration, the type and level of services to be provided and the current IMO Guidelines on the recruitment, qualifications and training of VTS operators. ***(further guidelines are elaborated in Annex 2)***		✓		Merak VTS has been provided with sufficient staff who capable of performing the required task. However, the recruitment standards for VTS operators are still missing.
2	establish appropriate qualifications and training requirements for VTS operators, taking into consideration the type and level of services to be provided.		✓		Merak VTS has established qualifications for VTS operators, consists of academic background, experience, and capabilities. In practice, not all these standards are fulfilled.
3	ensure that provisions for the training of VTS operators are available.		✓		Training Agency has been existed, either from the Government or also

					third parties. However, only some of VTSOs in Merak VTS have done the appropriate training.

- Annex 2

Objectives and Authority		Yes		No	Existing Condition
		Fully	Partially	Not at all	
Objectives					
The objectives of these Guidelines are to:					
1	Provide authorities with a logical process to follow in selecting and recruiting VTS operators, and in establishing qualification and training standards which will ensure that the necessary knowledge and skill profiles exist to enable them to carry out their functions to appropriate standards.	✓			The qualification for becoming the VTS operators is clear enough. The standard is referring to the Indonesia Ministry of Administrative and Bureaucratic Reform, No.34 Year 2011 about the Position Evaluation Guidelines.
2	establish knowledge and skill requirements and standards which VTS operators should meet with respect to certain functions.	✓			According to VTS staff leveling, which are staff, supervisor, and manager, the knowledge and skill requirement are also has been differentiated.
Competent Authority					
Subject to their own national and local requirements and constraints, then:					
1	Authorities will need to establish training requirements for their VTS operators.	✓			Directorate General of Sea Transportation (DJPL) has managed to establish training called BP2TL (*Balai Pendidikan dan Pelatihan Transportasi Laut*).
2	Authorities will also need to set specific knowledge, skill and personal suitability standards which operators must meet.	✓			Due to the training, the training agency always offers specific or special need from the VTS personnel. Therefore the training can be effective.

Framework		Yes		No	Existing Condition
		Fully	Partially	Not at all	
The framework outlines the steps that should be taken by a VTS authority to ensure that its VTS operators are competent to carry out assigned tasks. These steps are in two stages.					
1	Stage 1: Preliminary steps to be able to take decisions relative to operator competencies (prerequisites for the system).	✓			The authority has set the primary function and the goals of VTS itself and therefore can break down the competencies of operator it must have.
2	Steps 2: Steps to ensure that operators possess or achieve, and then maintain, the level of competence required to carry out their assigned functions (system parameters).		✓		Operators have the responsibility to do monitoring and need the skills and competencies to ensure their functions is well carried.

Prerequisites for the System		Yes		No	Existing Condition
		Fully	Partially	Not at all	
In order to be able to indentify, develop and implement a system for VTS operator qualification and training, authorities should first take a number of preliminary steps in order to ensure that the operator's competencies are appropriately aligned with the functions for which he/she is responsible. The steps are as follows:					
1	Implementing a VTS- make a decision, or have made a decision to implement a VTS.	✓			VTS has been implemented since 2015.
2	Identification of VTS functions- identify and describe the detailed functions relevant to the given VTS.	✓			Merak VTS carries out one functions, which is Information Service, and also Ship Reporting System as an addition.
3	Organization of VTS centre functions- organize the functions according to how they are to be carried out in accordance with the organization of the internal VTS operation.	✓			Organization of Merak VTS is stated in the #2.1.2 SOP of Merak VTS. There is three internal and external coordination in Merak VTS.
4	Establishment of VTS operator positions- to be prepared to establish, or have already established, operator positions within a VTS, determine what functions will be carried out from which positions, and be prepared to ensure that there		✓		The position for the VTS operator has been established. They are VTS operational staff, Supervisor VTS, and Manager VTS. Except for the manager, each of the position has

	will be personnel occupying those positions who have been given responsibility for carrying out the identified functions.				their own functions and responsibility, clearly written in the #1.1.2 SOP of Merak VTS.

System Parameters		Yes		No	Existing Condition
		Fully	Partially	Not at all	
General					
1	Authorities should have the ability to specify the background and prior experience a VTS operator should have, but due to some circumstances, they should however be able to specifiy the level of skill and knowledge that a recruit must have achieved based on this prior experience.		✓		The required abilities have been set. There are some aspects to be considered, such as the experience, academic background, certificates, and position as government employees. However, in practice, not all of these requirements are met by the candidate.
2	VTS authorities should therefore establish methods of assessing the skill and knowledge of recruits and existing VTS operators relative to the requirements of the tasks or functions they perform.	✓			The qualification for becoming the VTS operators is clear enough. The standard refers to the Indonesia Ministry of Administrative and Bureaucratic Reform, No.34 Year 2011 about the Position Evaluation Guidelines.
Recruitment and Selection					
1	Authorities should establish entry standards for new VTS operators coming into the system in terms of prior skills, knowledge, and personal suitability characteristics relevant to the tasks or functions they will be required to perform.		✓		According to the qualification standards that have to face reality, and due to the freshly new VTS implementation in Merak or Indonesia, the incompliance of candidate competence will be enhanced by the training.

2	VTS authorities may wish to consider introducing additional screening mechanisms to ensure that recruits have the necessary aptitudes, personal sitability characteristics, and ancillary skills for the functions they will be assigned.		✓		According to the qualification standards that have to face reality, and due to the freshly new VTS implementation in Merak or Indonesia, the incompliance of candidate competence will be enhanced by the training.
Qualifications					
1	Authorities must be able to determine what competencies a VTS operators must possess to carry out assigned functions, in order to establish the combination of prior qualifications and subsequent training required to ensure that their operators are competent.		✓		The qualification for becoming the VTS operators is clear enough. The freshly new candidate will have to carry out the On The Job Training first before receiving certificates and work as an operator.
2	VTS Authorities should analyse in detail the tasks which the operator will have to carry out in order to accomplish the specified functions, in terms of the skills and knowledge which he/she must possess to implement them successfully.	✓			The tasks of the operator are already described in #1.1.2 SOP of Merak VTS. Also, regarding the functions, the score that has to be fulfilled by the candidate is different.
3	Authorities must specify the types of skill and knowledge which operators must possess in order to perform their functions. These should be specified in such a way that authorities will be able to determine whether .1 VTS operators possess them in terms of their prior qualifications and experience; or .2 VTS operators possess them in terms of their prior qualifications and experience.		✓		The required abilities have been set. There are some aspects to be considered, such as the experience, academic background, certificates, and position as government employees. However, in practice, not all of these requirements are met by the candidate.

4	Authorities should determine to what level they must be possessed by a VTS operators. Authorities therefore have a responsibility to establish performance standards for skill and knowledge types to be acquired.		✓		The required abilities have been set. There are some aspects to be considered, such as the experience, academic background, certificates, and position as government employees. However, in practice, not all of these requirements are met by the candidate.
Training					
1	Authorities should establish concomitant training standards for those areas where they train VTS operators to the proficiency requirements of their positions.		✓		Several pieces of training are exist. However, only some of VTS operator that has been joining the training.
2	Based on the training standards, authorities should then be prepared to develop and implement a training programme which, when taken together with relevant existing experience, will provide the VTS operators with necessary skills and knowledge to perform his/her taks to required standards.	✓			Due to the training, the training agency always offers specific or special need from the VTS personnel. Therefore the training can be effective.
3	Authorities may also wish to consider the need to provide different types of training, with different levels relative to each type, in order to ensure the acquisition and maintenance of the relevant skills and knowledge necessary to meet job requirements.	✓			The authority has managed to provide several training else than operator, supervisors, and manager to comply with the different types of capabilities. They are such as technician, OJT instructors, and refreshment training.
4	Authorities may wish to institute a system of examinations to determine whether or not operator experience, qualifications and	✓			Every training is done for a certificate. Therefore if the candidate has accomplished the

	training are resulting in performance to required standards.				training, the certificate can be received.
5	Once suitably qualified and trained employees are performing on the job, their performance must be observed and monitored to ensure that it continues to meet the established standards.		✓		By standard, a team has to be consists of operator and supervisor VTS. VTS supervisor can observe and monitor the performance of employees. However, in reality, sometimes the operators do the watch themselves without a supervisor.
6	Authorities should be aware that for an operator to carry out VTS functions effectively, training may be required in areas not specifically related to VTS (e.g. typing, supervisory skills), and which are not specifically covered in these Guidelines.	✓			Due to the training, the training agency always offers specific or special need from the VTS personnel. Therefore the training can be effective.
Certifications					
1	Authorities may wish to introduce a formal system of certification as a means of ensuring and demonstrating users that a mechanism is in place which matches employee competence with task requirements.	✓			Every training is done for a certificate. Therefore if the candidate has accomplished the training, the certificate can be received.

Administrative Works' Aspects

General Consideration for VTS		Yes		No	Existing Condition
		Fully	Partially	Not at all	
VTS Services - VTS should comprise at least an information service and may also include others, such as a navigational assistance service or a traffic organization service, or both, defined as follows:		✓			VTS Services is stated in the #1 SOP Merak VTS and has been confirmed through observation and the interview.
1	An information service is a service to ensure that essential information becomes available in time for on-board navigational decision-making.	Yes			The INS of Merak VTS has been provided during 24 hours of operation.

2	A navigational assistance service is a service to assist on-board navigational decision-making and to monitor its effects.		If deemed necessary		The Merak VTS has not established NAS for daily services. Nevertheless, it can be provided when deemed necessary.
3	A traffic organization service is a service to prevent the development of dangerous maritime traffic situations and to provide for the safe and efficient movement of vessel traffic within the VTS area.			No	There is no consideration to upgrade service into NAS.

General Consideration for VTS		**Yes**		**No**	Existing Condition
		Fully	Partially	Not at all	
Objectives					
A clear distinction may need to be made between a Port or Harbour VTS and a Coastal VTS. A VTS could also be a combination of both types. The type and level of service or services rendered could differ between both types of VTS;			✓		Merak VTS has the responsibility to act as Port VTS and also Coastal VTS. This information obtained trough interview with Merak VTS Operator.
1	A Port VTS is mainly concerned with vessel Traffic to and from a port or harbour or harbours. Here, a navigational assistance service and/or a traffic organization service is usually provided.		Yes		Merak VTS together with PT ASDP IF Merak Banten to monitor ship traffic and ensure Port VTS is in good condition.
2	A Coastal VTS is mainly concerned with vessel traffic passing through the area. Here, usually only an information service is rendered.	Yes			Merak VTS always monitor all motion of vessel sailing through the area of Merak VTS.
Responsibilities and Liability					
In planning and establishing a VTS, the Contracting Government or Governments or the competent authority should :					
1	ensure that a legal basis for the operation of a VTS is provided for and that the VTS is operated in accordance with national and international law.	✓			The legal basis of operation has complied with national and international law as written as a reference in the SOP of Merak VTS.

2	ensure that objectives for the VTS are set.	✓			In #1 SOP of Merak VTS, The objectives are already set.
3	ensure that a VTS authority is appointed and legally empowered.	✓			In #1.1.2, the authority has been assigned, and the responsibility has been informed.
4	ensure that the service area is delineated and declared a VTS area; where appropriate, this area may be subdivided in sub-areas or sectors.	✓			In #1.1.1 SOP Merak VTS, the boundaries of Merak VTS in Sunda Strait has been declared.
5	determine the type and level of services to be provided, having regard to the objectives of the VTS.	✓			In #1 SOP of Merak VTS, The objectives are already set.
6	instruct the VTS authority to operate the VTS in accordance with relevant IMO resolutions.	✓			Merak VTS has considered the relevant resolution of IMO, as shown in its SOP.
7	establish a policy with respect to violations of VTS regulatory requirements, and ensure that this policy is consistent with national law. This policy should consider the consequences of technical failures, and due consideration should be given to extraordinary circumstances that result.	✓			The violation of VTS regulatory requirements has not been done boldly. Merak VTS still recommend following the rules and regulation, without policy.
In operating a VTS the VTS authority should:					
1	ensure that the objectives of the VTS are met.	✓			In #1 SOP of Merak VTS, The objectives are already set.
2	ensure that the standards set by the competent authority for level of services and operators qualifications and equipment are met.	✓			The VTSOs are able to speak English adequately and make sure the exchange information have well occurred.
3	ensure that the VTS is operated in conformity with relevant IMO resolutions.		✓		Merak VTS has considered the relevant resolution of IMO, as shown in its SOP.

4	ensure that the VTS operations are harmonized with, where appropriate, ship reporting and routeing measures, aids to navigation, pilotage and port operations.		✓		The VTSO knows well the instrument. This information proved through the observation.
5	consider, where appropriate, the participation of the pilot both as a user and provider of information.		✓		The VTSO always handle the communication over the pilot in case the related vessel need to have information.
6	ensure that a continuous listening watch on the designated radio frequencies is kept and that all published services are available during the operational hours of the VTS.		✓		The VTSO keep the continuous listening watch most of the time. But not always on its designated radio frequencies.
7	ensure that operating procedures for routine and emergency situations are established.		✓		The emergency has not been well established. Based on the casualties data history, it needs some time to recover the emergency.
8	in a timely manner, provide mariners with full details of the requirements to be met and the procedures to be followed in the VTS area. This information should be published in the appropriate nautical publications and in the "World VTS Guide". This information should include the categories of vessels required or expected to participate; radio frequencies to be used for reporting; areas of applicability; the times and geographical positions for submitting reports; the format and content of the required reports; the VTS authority responsible for the operation of the service; any information, advice or instructions to be provided to		✓		The VTSO informs related detail to the mariners through radio communication. There is no nautical publication established, so there might be some difficulties for mariners to enter and sailing through Sunda Strait area.

	participating ships; and the types and level of services available.				

Guidance for Planning and Implementing VTS		Yes		No	Existing Condition
		Fully	Partially	Not at all	
Responsibility for planning and implementing a VTS					
1	It is the responsibility of the Contracting Government or Governments or Competent Authorities to plan and implement vessel traffic services or amendments to such services.	✓			The Merak VTS is the unit of *Distrik Navigasi Kelas I* Tanjung Priok and is under the DJPL.
Guidance for planning a VTS					
1	Local needs for traffic management should be carefully investigated and determined by analysing casualties, assessing risks and consulting local user groups. Where the risks are considered VTS addresssable, in cases where monitoring of the traffic and interaction between Authority and participating vessel is considered to be essential, the implementation of a VTS, as an important traffic management instrument, should be considered.		✓		Merak VTS has coordinated with the National Transportation Safety Committee. In case there are any casualties happened in the sea, NTSC will do the investigation and share the result so that a similar incident can be prevented in the time ahead.
2	A VTS is particularly appropriate in an area that may include any of the following: high traffic density; traffic carrying hazardous cargoes; conflicting and complex navigation patterns; difficult hydrographical, hydrological and meteorological elements; shifting shoals and other local hazards; environmental considerations; interference by vessel traffic with other marine-based activities; a record of maritime casualties; existing or	✓			This information is gained from the data given. There is still a lack of establishment in handling the record of maritime casualties and there no appropriate cooperation between neighboring States.

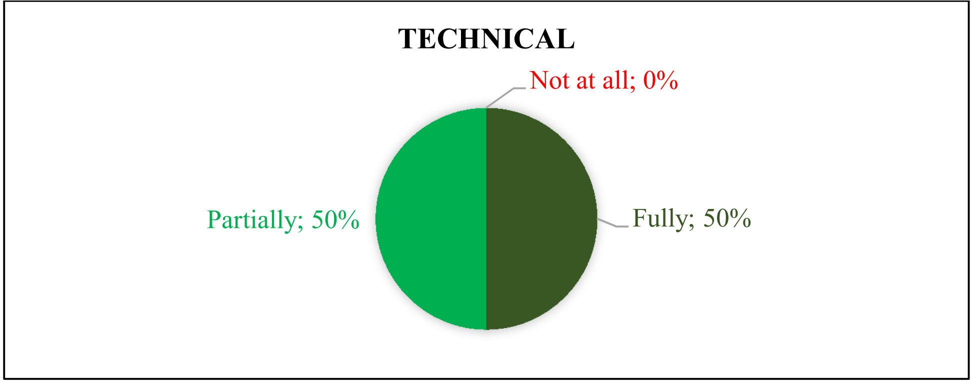
	planned vessel traffic services in adjacent waters and the need for co-operation between neighbouring States, if appropriate; narrow channels, port configuration, bridges and similar areas where the progress of vessels may be restricted; or existing or foreseeable changes in the traffic pattern resulting from port or offshore terminal developments or offshore exploration an exploitation in the area.				

Determining Skill and Knowledge Requirements Associated with VTS Functions		Yes		No	Existing Condition
		Fully	Partially	Not at all	
The objectives of traffic management functions and their relationship to the VTS services are briefly described below:					
1	Internal VTS functions: • data collection • data evaluation/decision making		✓		The collection of data has been stored.
2	Traffic management functions: • Primary function - allocation of space : This is effecting separation in space and/or time between vessels, or certain categories of vessel, by forward planning. It is a strategical function that can be performed by a traffic organization service. - routine control of vessel : This is a shipboard process to which a VTS contributes by supplying data relevant to the navigational decision-making process on board. This function relates to an		✓		The VTSO has provided the management functions to the mariners. The information or instruction will be made if the mariners ask the VTSO and the continuous information regarding this situation has not been well established. If Merak VTS has to handle over the service into the pilot or other supporting authority, the VTSOs are not maintaining or following up the information regarding this condition in the later time.

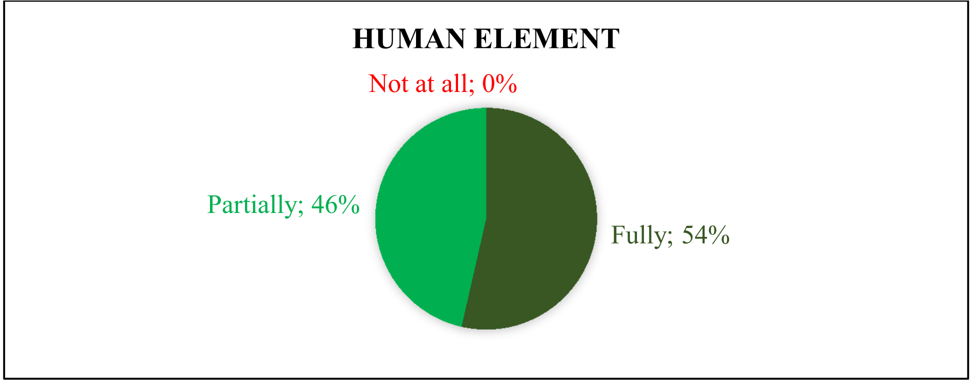
	information service and/or a navigational assistance service. - manoeuvres to avoid collisions : This is shipboard function concerning ships in encounter situations. It may be assisted by a VTS. It is a tactical function and relates to an information service and/or a navigational assistance service. • Enforcement funtion - Remedial Function - Other functions - Enforcement function : to encourage and monitor adherence to applicable rules and regulations and to take appropriate action where required and within the authority of the VTS. Some aspects of this function might be covered by a traffic organization service. - Remedial function : to reduce the effects and consequences of incidents, such as search and rescue, salvage and pollution. These functions may be performed by a VTS in support of allied activities. - Other function : to co-ordination and liaison between vessels and third parties. They may be performed by a VTS as support of allied activities.				

From the current list of IMO A.857(20), this resolution has a section for Technical Aspects, five sections for Human Element Aspects, and three sections for Administrative Works Aspects. Based on the student's finding, with regards to the Yes/No Question, and discussion with Merak VTS personnel to verify the result of the drafted items' lists, the fulfillment percentage of each aspect can be measured, as follows:

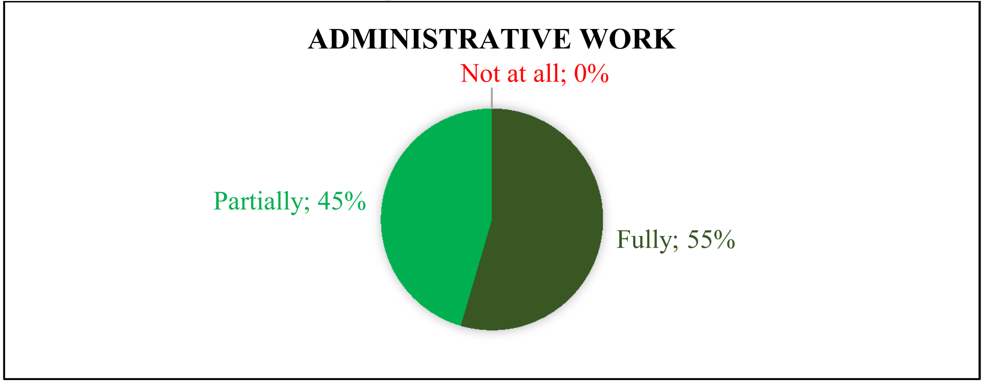
Technical's Aspect – covers 4% of all items in this resolution



Human Element's Aspect – cover 54% of all items in this resolution



Administrative Works' Aspect – cover 42% of all items in this resolution



Note: Score of 100% defines that the particular aspect has been entirely in accordance with *IMO Resolution A.857(20) in this preliminary study.*

2. IALA Guideline 1111 Edition 1.0 "Preparation of Operational and Technical Performance Requrements for VTS Systems"
The primary purpose of this document is to assist the VTS Authority in preparing the definition, specification, establishment, operation, and upgrades of a VTS system. The document addresses the relationship between the Operational Requirements and VTS system performance (Technical) requirements and how these reflect into system design and subsystem requirements (IALA, 2015a).

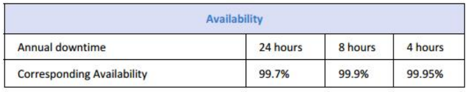
Requirements based on IALA Guideline 1111 also has all three categories, which are Technical, Human Element, and Administrative Work's Aspects. The descriptions are elaborated inside the table, as shown below.

Technical's Aspects

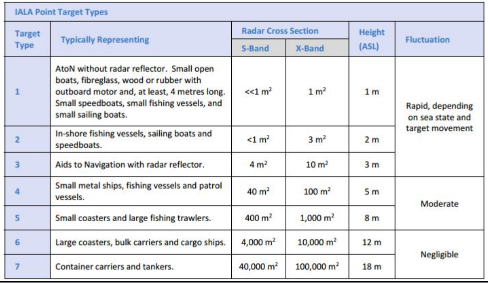
Core Operational and Technical Requirements		Yes		No	Existing Condition
		Fully	Partially	Not at all	
B. Technical Implementation Considerations					
Implementation of a VTS system requires consideration of:					
1	VTS Centre location(s).	✓			Merak VTS is located in Merak, Banten, with one control center to cover one sector of Sunda Strait area.
2	Available land and suitability of sensor sites.	✓			Merak VTS was built in the available land and has three other sensors sites to fed the data, which are located in Cipala Hill, Tempurung Island, and Cikoneng Lighthouse.
3	Sensor and radio coverage.		✓		The sensors and radio coverage supported the major operation. However, sometime the coverage range might be reduced and not cover all area during the bad weather.

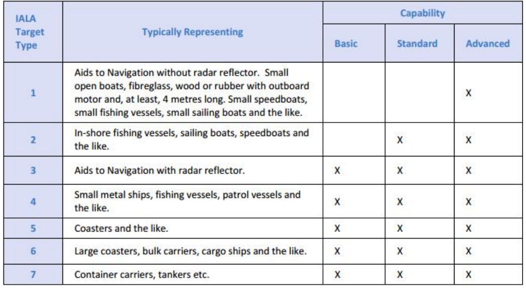
4	Overlapping coverage and equipment redundancy.	✓			An AIS and radar are in place to monitor the traffic. There is also supports for redundant configuration of the installed radar and AIS base station.
5	Existing infrastructure such as power and data lines.		✓		The Merak VTS has basic infrastructure necessary for conducting decent surveillance. The uninterruptible power supply (UPS) has also been installed.
6	Communication routes.	✓			In #1.1.1 SOP of Merak VTS, communication with the participating vessel is provided through Ch 16 and Ch 20. The communication system used Radio-link 24 GHz in four sites.
7	Environmental constraints and impact.	✓			Merak VTS has considered the environment situations by having a weather station in Cipala hill and periodic update from the Meteorological, Climatology, and Geophysical Agency of Indonesia (BMKG).

8	Operating conditions such as wind, influence from sea, precipitation and possibly ice.	✓			In accordance with BMKG, Merak VTS get period update much as eight times in a day.
9	Electromagnetic issues (EMI/EMC).	✓			The equipment installed conforms to the current electromagnetic compatibility regulations. There are also technicians on duty available to do the maintenance.
10	Applicable regulations and required licenses (transmission, building etc.).	✓			The building located on significant place with indoor and outdoor security camera. The equipment meets the IALA Standard recommendations and functionality of IEC.
11	Selection of installation sites with due respect to neighbors.		✓		Merak VTS Centre is located beside the port area, terminal station, a highway, and around the village area. However, the other installation sites are located quite some distance with neighbors.

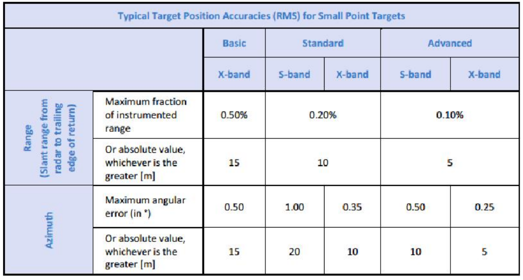
<table>
<tr><td>12</td><td>Security and site access.</td><td></td><td>✓</td><td></td><td>The site in Merak VTS is easy to be accessed and there is also a security control in the entrance. However, the enclosed security fences or building perimeters have not seen to present the “limited area” access.</td></tr>
<tr><td>13</td><td>1. Availability and Reliability
Relation between downtime and availability
<table><tr><th colspan="4">Availability</th></tr><tr><td>Annual downtime</td><td>24 hours</td><td>8 hours</td><td>4 hours</td></tr><tr><td>Corresponding Availability</td><td>99.7%</td><td>99.9%</td><td>99.95%</td></tr></table>2. Recording, Archiving and Replay
*Within legal limitations, provision should be made for the storage, security, retrieval and presentation of VTS data.
*A minimum of 30 days' storage capacity is recommended, which should allow the full retrieval of data post-incident/accident.
*The data should be recorded automatically and be capable of replay without impact to on-going VTS operations.</td><td></td><td>✓</td><td></td><td>The operational hour of Merak VTS is 24 hours. According to the observation, the spare parts as required were not readily available, which therefore might decrease the availability figure. There is a device for recording and playback data. However, the fleet data were recorded manually taken source from the daily logbook made by the VTSO in each month.</td></tr>
</table>

Radar	Yes		No	Existing Condition
	Fully	Partially	Not at all	
Target Types for Range Coverage Modelling				
Typical targets of interest are modelled as point targets with conservative estimate of Radar Cross Section and height. This is normally sufficient for estimation of detection range for consideration in VTS radar sensor coverage.		✓		The radar has been installed as the sensor system for the medium-range surface surveillance in Merak VTS. The

<table>
<tr>
<td>IALA Target Types

<table>
<tr><th colspan="6">IALA Point Target Types</th></tr>
<tr><th rowspan="2">Target Type</th><th rowspan="2">Typically Representing</th><th colspan="2">Radar Cross Section</th><th rowspan="2">Height (ASL)</th><th rowspan="2">Fluctuation</th></tr>
<tr><th>S-Band</th><th>X-Band</th></tr>
<tr><td>1</td><td>AtoN without radar reflector. Small open boats, fibreglass, wood or rubber with outboard motor and, at least, 4 metres long. Small speedboats, small fishing vessels, and small sailing boats.</td><td><<1 m²</td><td>1 m²</td><td>1 m</td><td rowspan="3">Rapid, depending on sea state and target movement</td></tr>
<tr><td>2</td><td>In-shore fishing vessels, sailing boats and speedboats.</td><td><1 m²</td><td>3 m²</td><td>2 m</td></tr>
<tr><td>3</td><td>Aids to Navigation with radar reflector.</td><td>4 m²</td><td>10 m²</td><td>3 m</td></tr>
<tr><td>4</td><td>Small metal ships, fishing vessels and patrol vessels.</td><td>40 m²</td><td>100 m²</td><td>5 m</td><td rowspan="2">Moderate</td></tr>
<tr><td>5</td><td>Small coasters and large fishing trawlers.</td><td>400 m²</td><td>1,000 m²</td><td>8 m</td></tr>
<tr><td>6</td><td>Large coasters, bulk carriers and cargo ships.</td><td>4,000 m²</td><td>10,000 m²</td><td>12 m</td><td rowspan="2">Negligible</td></tr>
<tr><td>7</td><td>Container carriers and tankers.</td><td>40,000 m²</td><td>100,000 m²</td><td>18 m</td></tr>
</table>
</td>
<td></td>
<td></td>
<td></td>
<td>radar is a fully comprehend pulse compression and has coverage until 48 nm. However, there is no explanation about the radar cross-section and height of the target.</td>
</tr>
<tr><td colspan="5">Targets to be Detected</td></tr>
<tr>
<td>The radar detection performance should be sufficient to meet the VTS operational requirement in the individual VTS areas. This includes detection and tracking all types of surface objects defined by the VTS Authority in weather conditions typical for the individual site. Special local conditions such as heavy rainfall should also be considered. Additional factors affecting the detection performance of radar systems include noise, interference, clutter and propagation.

Targets to be Detected

<table>
<tr><th rowspan="2">IALA Target Type</th><th rowspan="2">Typically Representing</th><th colspan="3">Capability</th></tr>
<tr><th>Basic</th><th>Standard</th><th>Advanced</th></tr>
<tr><td>1</td><td>Aids to Navigation without radar reflector. Small open boats, fibreglass, wood or rubber with outboard motor and, at least, 4 metres long. Small speedboats, small fishing vessels, small sailing boats and the like.</td><td></td><td></td><td>X</td></tr>
<tr><td>2</td><td>In-shore fishing vessels, sailing boats, speedboats and the like.</td><td></td><td>X</td><td>X</td></tr>
<tr><td>3</td><td>Aids to Navigation with radar reflector.</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>4</td><td>Small metal ships, fishing vessels, patrol vessels and the like.</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>5</td><td>Coasters and the like.</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>6</td><td>Large coasters, bulk carriers, cargo ships and the like.</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>7</td><td>Container carriers, tankers etc.</td><td>X</td><td>X</td><td>X</td></tr>
</table>
</td>
<td></td>
<td>✓</td>
<td></td>
<td>Merak VTS has settled X-Band radar which can represent from large vessels, such as container carriers and tanker, to small vessels, such as tug boat and pleasure craft. The radar has a minimum detection range of 30 m. The dynamic processing range is more than 100 dB. Meanwhile, the noise figure is typically 2.5 dB. From the interview, rainfall might affect radar performance.</td>
</tr>
<tr><td colspan="5">Calculation on Radar Detection Performance</td></tr>
<tr>
<td>The achievable target detection range is highly dependent on several factors including antenna height, target characteristics, weather and atmospheric propagation conditions. Furthermore, in the design of radar systems it is very important not only to focus on maximum detection range but also on radar quality at all ranges, the ability to handle clutter, the ability to suppress interferences and the ability to simultaneous handling of defined (small and large) targets in the VTS area covered by radar.

Calculation for magnetron radars can be performed by the CARPET Program.</td>
<td></td>
<td>✓</td>
<td></td>
<td>The radar meets the requirements for professional VTS applications in quality and durability. It is installed with 18’ compact antenna, and the transceiver also works with smaller antennas. However, no written report of calculation for performing the magnetron radars.</td>
</tr>
</table>

<table>
<tr><td colspan="5">Target Separation</td></tr>
<tr><td>In normal weather and propagation conditions, surface objects within the VTS area should be separated in presentation, and individually tracked without track swap, at any applicable target speed when they are positioned apart and with distances as defined by the individual VTS Authority. Target separation is achieved by a combination of range and azimuth (and Doppler, when available).
Typical Range Separation
<table>
<tr><td colspan="5">Typical Range Separation of Small Point Targets [m]</td></tr>
<tr><td colspan="2" rowspan="2"></td><td>Basic</td><td>Standard</td><td>Advanced</td></tr>
<tr><td colspan="3">-6 dB points</td></tr>
<tr><td rowspan="3">Minimum Range Separation</td><td>Less than 5 NM instrumented range</td><td>25</td><td>20</td><td>15</td></tr>
<tr><td>5-20 NM instrumented range</td><td>75</td><td>60</td><td>50</td></tr>
<tr><td>More than 20 NM instrumented range</td><td>N/A</td><td>100</td><td>80</td></tr>
</table>
Typical Azimuth Separation
<table>
<tr><td colspan="6">Typical Azimuth Separation of Small Point Targets</td></tr>
<tr><td rowspan="3"></td><td colspan="3">X-Band Radar</td><td colspan="2">S-Band Radar</td></tr>
<tr><td>Basic</td><td>Standard</td><td>Advanced</td><td>Standard</td><td>Advanced</td></tr>
<tr><td colspan="5">-6 dB points</td></tr>
<tr><td>Azimuth separation in angle (in °)</td><td>1.0</td><td>0.6</td><td>0.5</td><td>2.4</td><td>1.5</td></tr>
<tr><td>Or distance, whichever is the greater [m]</td><td>25</td><td>20</td><td>15</td><td>20</td><td>15</td></tr>
</table></td><td></td><td>✓</td><td></td><td>Since the radar is a solid-state radar type, the sensors can work together without any in-band interference and it has the option to upgrade a Doppler unit for processing the Doppler Effects. In addition, it guarantees the higher scanning capabilities and high-quality transmission of signals to the receiver by allowing the antenna tilted up. The radar has standard range separation of small point targets. However, data were not found for the angle and distance azimuth.</td></tr>
<tr><td colspan="5">Target Position Accuracy</td></tr>
<tr><td>The system should be designed in such a way that the defined radar target accuracy is aligned to the core operational requirements.
Typical Target Position Accuracies
<table>
<tr><td colspan="7">Typical Target Position Accuracies (RMS) for Small Point Targets</td></tr>
<tr><td colspan="2" rowspan="2"></td><td>Basic</td><td colspan="2">Standard</td><td colspan="2">Advanced</td></tr>
<tr><td>X-band</td><td>S-band</td><td>X-band</td><td>S-band</td><td>X-band</td></tr>
<tr><td rowspan="2">Range (Slant range from radar to trailing edge of return)</td><td>Maximum fraction of instrumented range</td><td>0.50%</td><td colspan="2">0.20%</td><td colspan="2">0.10%</td></tr>
<tr><td>Or absolute value, whichever is the greater [m]</td><td>15</td><td colspan="2">10</td><td colspan="2">5</td></tr>
<tr><td rowspan="2">Azimuth</td><td>Maximum angular error (in °)</td><td>0.50</td><td>1.00</td><td>0.35</td><td>0.50</td><td>0.25</td></tr>
<tr><td>Or absolute value, whichever is the greater [m]</td><td>15</td><td>20</td><td>10</td><td>10</td><td>5</td></tr>
</table></td><td>✓</td><td></td><td></td><td>The radar has a standard of target position accuracies. According to the manual of Kongsberg CSET for Merak VTS, a small steady-state target with 10 to 20 knots speed at 5 Nm range are having a range of 10 m, bearing of 0.4°, course of 2.0°, and speed of 0.8 knots.</td></tr>
</table>

<table>
<tr><td rowspan="2">Automatic Identification System</td><td colspan="2">Yes</td><td>No</td><td rowspan="2">Existing Condition</td></tr>
<tr><td>Fully</td><td>Partially</td><td>Not at all</td></tr>
<tr><td colspan="5">Responsibility for planning and implementing a VTS</td></tr>
<tr><td colspan="5">It is the responsibility of the Competent and VTS Authorities to plan and implement vessel traffic services or amendments to such services.</td></tr>
</table>

1	AIS operates within the marine VHF band and has the same limitations as VHF Communication.	✓			The AIS BS610 receives and communicates AIS data from all AIS sources within the VHF coverage area.
2	AIS reported position is primarily based on GNSS-sourced positional data with associated capabilities and constraints.	✓			According to the manual of Kongsberg Seatex, the AIS is able to broadcast DGNSS corrections through the standardized AIS message 17.
3	VTS Authorities could consider recommending Class-A devices for non-SOLAS vessels that participate in VTS or provide support for VTS operations.	✓			The recommendations could be given if needed. Nevertheless, the monitoring for vessels equipped with no AIS system has been maintained through radar.
Objective					
1	Automatically receive information from AIS-equipped vessels, including the ship's identity, ship type, position, course and speed over ground, navigational status, and safety-related informations.	✓			All data is received and verified through communication between the VTSO and the vessel.
2	Monitor and track AIS-equipped vessel.	✓			The VTSO can monitor and track the AIS-equipped vessel.
3	Exchange data with AIS-equipped vessel.	✓			The information could be exchanged with mariners.
4	Support value added functions over the AIS infrastructure.	✓			The DJPL established AIS Base Station in Cipalla Hill and assigned the technician to do the maintenance.
5	Manage AIS-based Aids to Navigation (including virtual and synthetic AtoN).		✓		The DJPL has managed physical aids, such as Lighthouses, Buoys, and Beacons. However, the data of the AIS AtoN are limited.
6	Provision of vessel identification and location information to the VTS traffic image	✓			The vessel traffic situation is integrated and managed through the ECDIS.
7	Provision of vessel manoeuvring and voyage related data to the VTS.	✓			The information is integrated and confirmed

					by VTSO via communication.
8	Provision of facilities to enable transmission of information between the VTS and the mariner.	✓			The information is given periodically to the mariners, for example, the navigational information and sea state.
Equipment					
The physical Equipment options for a VTS Authority are as follows:					
1	AIS base station.	✓			The AIS BS610 is installed.
2	AIS limited base station.		✓		The installed AIS base station is sufficient.
3	AIS receiver.	✓			According to the manual, the integrated receiver with the base station has a strong focus on signal reception.
4	AIS repeater.	✓			The function of AIS repeater is in accordance with the IEC 62320-3.
5	AIS Aid to Navigation (AtoN).		✓		The base station supports the sources of AIS AtoN unit. However, the data is limited.

Environmental Monitoring		Yes		No	Existing Condition
		Fully	Partially	Not at all	
The VTS should consider two aspects of environmental monitoring :					
1	navigational data collection Navigational data collection includes the traditional environment monitoring sensors, typically referred to as the hydrological/ meterological (hydro/meteo) systems.	✓			The weather station has been installed in Cipala Hill to provide meteorological sensors. Nevertheless, the periodical data from BMKG are used by the VTSO to report the situation to mariners.
2	environmental protection An environmental protection system provides early detection of any polluting incidents that may be caused by visiting vessels. This software processing of the VTS radar signals or by specialist sensors are designed			✓	There is no system for detecting polluting incidents to protect the environment.

	to detect oil, or other pollutants, in the water.				
Characteristics of Environmental Sensors in VTS					
For hydro/meteo systems within a VTS system, measurement sensors should be installed and located by the VTS Authority in consultation with hydrologist/meteorologist(s) and Local Authority standards. The sensor identification and location should be provided. The measurement/sensors may include:					
1	wind speed/wind direction/wind gust.	✓			The weather station measures wind speed and direction, temperature and relative humidity, liquid precipitation, barometric pressure, visibility, sea level, and tide, wave height, period, and direction. However, there is no indication of wave height anomalies to indicate oil spill.
2	air temperature/relative humidity.	✓			
3	precipitation.	✓			
4	barometric pressure.	✓			
5	visibility.	✓			
6	water temperature/water level.	✓			
7	height of tide.	✓			
8	current speed.	✓			
9	current direction.	✓			
10	wave height/direction (also used to indicate wave height anomalies that might indicate oil spill).		✓		
11	ice coverage/thickness.	-	-	-	The sea state is ice-free.
Operational Requirement					
Where a VTS Authority determines a need to establish their own monitoring stations, it should be noted that the individual VTS Authorities, in conjunction with hydrographical and meteorological experts, should determine the accuracy and availability for each VTS Centre, as these will be based on individual circumstances.		✓			The Merak VTS is supported by weather station of VAISALA WXT530 in Cipalla Hill. Nevertheless, the other update and adequate information is received periodically from the BMKG.

Electro-Optical Systems	Yes		No	Existing Condition
	Fully	Partially	Not at all	
An Electro-Optical System (EOS) consists of imaging devices, such as daylight CCTV, day/night CCTV, infrared- and laser-illuminated camera.		✓		According to the observation, there is a CCTV installed but currently on repair and also new installation. The long-range camera is located in the Tempurung Island.
Characteristics				
An EOS is made up to the following components:				

1	The imaging device that produces the actual electronic image.	✓			The CCTV and long-range camera produce actual the electronic image.
2	The lens that creates the field of view and focuses the incoming light onto the image device.	✓			The camera is an infrared of long-range multi sensor instrumentation camera.
3	The sensor housing.	✓			The camera has a rugged military-grade and sealed from extreme weather.
4	For Pan, Tilt, Zoom (PTZ) EOS, the electromechanical system that moves the camera and allows the lens to zoom in and out.	✓			The camera provides PTZ camera system, consists of over 2 km of zoom laser infrared diode, up to 1000 mm HD zoom lens.
Functional Requirements					
1	Pan, Tilt, and Zoom PTZ sensors can be controlled directly by the VTSO, typically using a joystick or keyboard. PTZ sensors can be a shared resource between, for example, a Harbour Master and VTS, therefore the VTS Authority may need to publish a code of practice to govern EOS sensor operation. The PTZ could also be controlled through the VTS Application.		✓		The camera provides PTZ system. According to the minimum technical requirements of the camera, the camera system has a software development kit that allows the user to control the functionality. However, since the equipment is on repair and new installation, the functional requirements could no be obtained.
2	Precision and Repeatability Precision referes to the ability to set the pan, tilt and zoom to the requested position within a certain tolerance. Repeatability refers to the ability to reliably recreate a certain setting.		✓		The camera provides an accurate pan/tilt system of ±1 degree and able to collect data to a target in the 9-13 micron band from 0.5 to 13 km.
3	Image Processing.		✓		The software is compatible with Windows 7. However, there is no information about image processing.
4	Configuration VTSOs should only need to have access to an agreed set of operational functions. Configurations, tuning, maintenance and advanced set-up functions should be		✓		The VTSOs supposedly could operate the equipment. Meanwhile, the maintenance is handled by the technician. However, there is less

	restricted to designated support personnel.				information about this through the observation.

<table>
<tr><th rowspan="2" colspan="2">Radio Direction Finders</th><th colspan="2">Yes</th><th>No</th><th rowspan="2">Existing Condition</th></tr>
<tr><th>Fully</th><th>Partially</th><th>Not at all</th></tr>
<tr><td colspan="6">Operational Requirements</td></tr>
<tr><td colspan="6">VTS Authorities should consider the need for an RDF system based on the type of traffic in the VTS area. The VTS Authority should assess the requirement for a RDF system based on a risk assessment of these and other relevant factors. When a RDF system is assessed as being necessary, the VTS authorities should, at least, consider the following:</td></tr>
<tr><td>1</td><td>the required RDF coverage area.</td><td>✓</td><td></td><td></td><td>There is a consideration to install RDF in Cipala Hill.</td></tr>
<tr><td>2</td><td>the declared VTS level of capability and possible responsibilities for SAR.</td><td>✓</td><td></td><td></td><td>The Merak VTS provides INS and has coordination with SAR in case of emergency.</td></tr>
<tr><td>3</td><td>the required bearing accuracy.</td><td>✓</td><td></td><td></td><td>The bearing accuracy is better than ±5° RMS.</td></tr>
<tr><td>4</td><td>the required frequency range of the RDF equipment (this may include frequencies used for SAR).</td><td>✓</td><td></td><td></td><td>The RDF receives not only emergency signals on the 121.5 MHz frequency but also voice communication on the marine band.</td></tr>
<tr><td>5</td><td>the number of simultaneously monitored VHF channels.</td><td>✓</td><td></td><td></td><td>The RDF is available of all 88 channels (156.000 to 162.025 MHz) of the marine band.</td></tr>
<tr><td>6</td><td>other influencing factors, such as obstructions in the line of sight and the presence of potential reflective surfaces, which may reduce the performance of an RDF system.</td><td>✓</td><td></td><td></td><td>The RDF has a very high receiver sensitivity to permit detection of the very weak or remote signal. It is waterproof and illuminated to use at night.</td></tr>
<tr><td>7</td><td>Provision of vessel manoeuvring and voyage related data to the VTS.</td><td>✓</td><td></td><td></td><td>The RT-300 RDF is used as a navigation aid in a single unit.</td></tr>
<tr><td>8</td><td>Provision of facilities to enable transmission of information between the VTS and the mariner.</td><td>✓</td><td></td><td></td><td>The RDF has a completely automatic operation providing fast, stable display of data.</td></tr>
<tr><td colspan="6">Functional Requirements</td></tr>
<tr><td>1</td><td>VHF Channel Management.</td><td>✓</td><td></td><td></td><td>The RDF receives frequencies from VHF marine and airband.</td></tr>
</table>

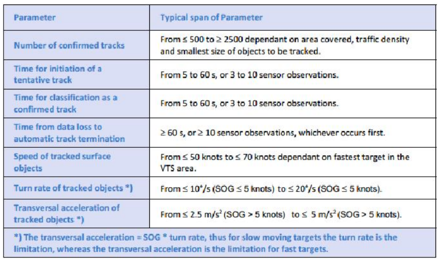
2	SAR Functionality.	✓			The RDF is a communication and a SAR direction finder.
3	Man Overboard EPIRB Detection Capabilities.	✓			The system is a MOB device to guarantee crew safety.
4	COSPAS/SARSAT Detection and Decoding.		✓		It detects the very weak or remote signal. However, there is no information about this function.

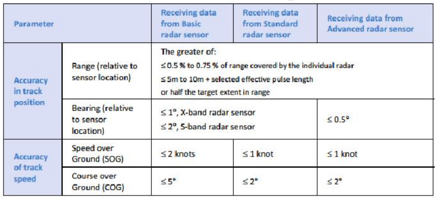
Long Range Sensors		Yes		No	Existing Condition
		Fully	Partially	Not at all	
The use of information derived from long-range sensors can provide supplementary information. It may assist in locating vessels that have not arrived on schedule or detect vessels that arrive unannounced. It allows authorities to assesss potential security risks or, should the need arise, provide input data for search planning in case of a SAR incident. Typical long range sensors include:					
1	LRIT (Long Range Identification and Tracking).			✓	The LRIT has never been mentioned or informed through observation and technical data of Merak VTS.
2	Satellite AIS (SAIS).		✓		Besides AIS Base Station, information from AIS transceiver could be obtained by AIS receiver satellite. However, the information about SAIS is limited.
3	HF Radar.		✓		From the observation, Merak VTS has MF and HF radar. However, information is limited.
4	Satellite-based Synthetic Aperture Radar (SARSAT).			✓	The SARSAT has never been mentioned or informed through observation and technical data of Merak VTS.
Operational Requirements					
1	Radio Communication Coverage As minimum requirement, the radio communication range should facilitate VTS ship communications before the ship enters a VTS area of responsibility.	✓			The radio communication equipment to guarantee the coverage of GMDSS Area A2 has been facilitated by VHF, HF, and MF. The designated channel is written in #1.1.1 SOP of Merak VTS.

2	Recording and Playback of Data The VTS Authority should have the facility to automatically record radio communications and play back their recordings in synchronisation with the recorded traffic situation.		✓		According to the manual, the C-Scope Logging and Replay system records tracks, digital radar video, voice communications, VHF/DF data, CCTV images, and operator actions. It stores real-time data for later playback. However, the finding from observation and interview have not shown the presence of these operational requirements.

Data Processing		Yes		No	Existing Condition
		Fully	Partially	Not at all	
The Tracking and Data Fusion consider sensor data from various sources including :					
1	radar sensors.	✓			According to the manual of the C-Scope Operator Client (CSOC), the system can support a wide array of sensors including radar, AIS, SAIS, CCTV, RDF, environmental hydrometeorological, satellite ground station data, subsea tracking, thermal imagery, voice and GMDSS system.
2	adjacent VTS area or other agency tracks.		✓		
3	AIS and Satellite AIS.	✓			
4	LRIT.		✓		
5	Electro-Optical System (EOS).	✓			
Tracking and Data Fusion					
1	Plot Extraction, process between the collection of raw sensor data and the extraction of useful information from that data.	✓			According to the manual of C-Scope Operator Client (CSOT), the extractor uses a special radar interface and data acquisition card to sample the signals from the radar.
2	Tracking, consists of Plot-to-Track Association, Track Initiation, and Track Maintenance.	✓			According to the manual, the C-Scope Extractor and Tracker (CSET) detects, tracks, and plots

					objects from the input radar signal. Therefore, an existing track might be associated, or new track might be initiated automatically, manually or by handover from a track fusion engine that integrates tracks from other sources such as other radars and AIS.
3	Track Data Output.	✓			According to the manual, the echoes from the extractor and the integrated tracks will be converted into output digital video for presentation and display at the operator console.
4	Track Management, consists of Track Termination and Track Identification.	✓			According to the manual, each plot is checked against the tracks corresponding to tracked targets. If specific criteria are fulfilled, the plot is associated with an existing track. Otherwise, the new track will be plotted.
5	Environment Assessment.		✓		The CSOC can exchange data from other sources to provide other services such as incident management, management information service, and web map service. It also allows additional services to create and maintain an AIS network such as AIS network management.

<table>
<tr><td></td><td></td><td></td><td></td><td></td><td>However, the interview and observation have not shown the presence of this system.</td></tr>
<tr><td>6</td><td>Tracking and Data Fusion Performance Parameters.
The VTS system design should ensure that the achievable performance is aligned with the required performance for each of the areas within the VTS coverage area. The following tables discuss some of the tracker performance parameters and criteria that may be considered.
Typical System Tracking Performance Parameters

<table>
<tr><th>Parameter</th><th>Typical span of Parameter</th></tr>
<tr><td>Number of confirmed tracks</td><td>From ≤ 500 to ≥ 2500 dependant on area covered, traffic density and smallest size of objects to be tracked.</td></tr>
<tr><td>Time for initiation of a tentative track</td><td>From 5 to 60 s, or 3 to 10 sensor observations.</td></tr>
<tr><td>Time for classification as a confirmed track</td><td>From 5 to 60 s, or 3 to 10 sensor observations.</td></tr>
<tr><td>Time from data loss to automatic track termination</td><td>≥ 60 s, or ≥ 10 sensor observations, whichever occurs first.</td></tr>
<tr><td>Speed of tracked surface objects</td><td>From ≤ 50 knots to ≤ 70 knots dependant on fastest target in the VTS area.</td></tr>
<tr><td>Turn rate of tracked objects *)</td><td>From ≤ 10°/s (SOG ≤ 5 knots) to ≤ 20°/s (SOG ≤ 5 knots).</td></tr>
<tr><td>Transversal acceleration of tracked objects *)</td><td>From ≤ 2.5 m/s² (SOG > 5 knots) to ≤ 5 m/s² (SOG > 5 knots).</td></tr>
<tr><td colspan="2">*) The transversal acceleration = SOG * turn rate, thus for slow moving targets the turn rate is the limitation, whereas the transversal acceleration is the limitation for fast targets.</td></tr>
</table>

Single Radar Sensor - Tracking Performance Parameters (specific)

<table>
<tr><th colspan="2">Parameter</th><th>Receiving data from Basic radar sensor</th><th>Receiving data from Standard radar sensor</th><th>Receiving data from Advanced radar sensor</th></tr>
<tr><td rowspan="2">Accuracy in track position</td><td>Range (relative to sensor location)</td><td colspan="3">The greater of:
≤ 0.5 % to 0.75 % of range covered by the individual radar
≤ 5m to 10m + selected effective pulse length
or half the target extent in range</td></tr>
<tr><td>Bearing (relative to sensor location)</td><td colspan="2">≤ 1°, X-band radar sensor
≤ 2°, S-band radar sensor</td><td>≤ 0.5°</td></tr>
<tr><td rowspan="2">Accuracy of track speed</td><td>Speed over Ground (SOG)</td><td>≤ 2 knots</td><td>≤ 1 knot</td><td>≤ 1 knot</td></tr>
<tr><td>Course over Ground (COG)</td><td>≤ 5°</td><td>≤ 2°</td><td>≤ 2°</td></tr>
</table>
</td><td>✓</td><td></td><td></td><td>According to the manual, the CSET has features and performance as in accordance with the recommendation of IALA Guideline 1111. It can confirm tracks of 1000 moving targets, 250 stationary targets, and 250 navigation aids. The target speed limit is configurable, but typically 0 to 70 knots for VTS application. The turning rate depends on target speed, but typically 20°/s at 5 knots, 10°/s at 10 knots, and 5°/s at 20 knots or greater. When referring to the second table, receiving data is obtained from the standard radar sensor. It is proved by the tracking accuracy with the bearing of ± 0.4° for, speed of ± 0.8 knots, and course of ± 2.0°.</td></tr>
<tr><td colspan="6">Management of VTS Data</td></tr>
<tr><td colspan="6">Centralised data fusion aims to integrate data from different systems at regional or national level using inter system data exchange. Types of information may include :</td></tr>
<tr><td>1</td><td>voyage data.</td><td>✓</td><td></td><td></td><td>Based on the #3.1.1 SOP of Merak VTS.</td></tr>
<tr><td>2</td><td>vessel data.</td><td>✓</td><td></td><td></td><td>Based on the #3.1.1 SOP of Merak VTS.</td></tr>
<tr><td>3</td><td>incident data.</td><td>✓</td><td></td><td></td><td>Based on the #3.2.1. SOP of Merak VTS.</td></tr>
<tr><td>4</td><td>contacts data.</td><td>✓</td><td></td><td></td><td>From the coordination with Port Authority and ships agent.</td></tr>
</table>

5	Charts.	✓			Based on the #2.2.1 SOP of Merak VTS.
6	pilots and tugs.	✓			From the coordination with Pilotage and Tug.
7	data of berths and capabilities plus other port resources.			✓	From the coordination with Port Authority. However, no information about this data through the observation.
8	traffic analysis data.			✓	According to the installed server system, traffic analysis data can be obtained. However, observation and interview have not shown the utilization of traffic analysis data.
9	local hazard.		✓		Based on the #3.2.1 SOP of Merak VTS. However, the less concern about local hazard was seen through the observation.
10	VTS Equipment status, build state, version records.		✓		Referring to the information from the technician, the GMDSS equipment was installed in 2016 and the server system for AIS, CCTV, VHF radio, and radar was installed in 2012. There was also a work station and UPS. However, the report for a record and an update of equipment were hardly seen.
11	VTS spares and consumables stock and storage locations.			✓	There was no data obtained for this. From the observation and interview, the spares unit were not available.

12	VTS equipment fault records.	✓			Based on the #2.2.1 SOP of Merak VTS.
13	VTS equipment scheduled and unscheduled maintenance.		✓		The unscheduled maintenance was based on the Equipment Outage Report in #2.2.1 SOP of Merak VTS. However, observation and interview showed no scheduled maintenance.
14	VTS personnel.	✓			Based on the #1.1.3 SOP of Merak VTS.

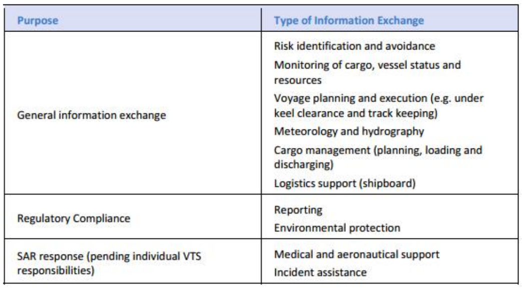
VTS Human/Machine Interfaces		**Yes**		**No**	Existing Condition
		Fully	Partially	Not at all	
Operational Requirements					
1	Traffic Image and Information Display	✓			According to the manual of CSOC, the traffic situation can be viewed in 2D or 3D view.
2	Environmental Information		✓		The CSOC allows the operator to view relevant and timely environmental information directly on the chart. However, this function has not been seen through observation. The information from BMKG is mostly used.
3	Decision Support Presentation		✓		The CSOC has tools for predicting and analyzing tracks movement, weather behavior, and oil spills, amongst others to enhance decision support. However, the functions other than tracks movement were rarely used from the conducted observation.
4	Electro-Optical Sensor Data Display and Control		✓		From the observation and interview, the EOS is on repair and seldom used for the VTSO during monitoring.
Functional Requirements					
The HMI should be capable of presenting the overall status of all the major system elements/subsystems and the infrastructure. Typically, this will include communications, sensors, and main Information			✓		The CSOC HMI provides a single chart view and allows the operator to access the information from the user interface. The VTSO could control the chart view, access chat, notified by the track

Technology (IT) hardware elements. The commnications could be as data and voice, meanwhile the main ITS elements could be servers, processors, PC, workstations, and data storage.				warnings, system warnings, and AIS messages, also access the current traffic situation. However, the function of notification has not been well utilized through the conducted observation.

Decision Support		Yes		No	Existing Condition
		Fully	Partially	Not at all	
Characteristics of Decision Support Tools					
1	Decision Support may consider such aspects as environmental monitoring and forecasts, vessel behavior, vessel traffic development, legal criteria, incident management, organizational and operational procedures.	✓			From the observation and interview, the mentioned aspects have been considered by the operation of Merak VTS. Nevertheless, the detail operation is merely identified by preliminary study through observation and interview.
2	Decision Support Tools may also be used to evaluate the performance of the VTS itself		✓		The server system of CSOC could be integrated into a number of additional tools to enhance decision support, such as audio or visual alerts when a track has violated certain criteria. However, the performance of Decision Support Tools of Merak VTS has not been mentioned and merely identified through the observation and the interview.
3	Decision Support Tools should be able to assist decision-makers by providing facilities that aid the management of risk situations and, thereby, reduce the level of risk.		✓		
Decision Support Functions for Operational Requirements					
1	Collision Avoidance Closest Point of Approach (CPA) and Time to Closest Point of Approach (TCPA) are numerical indices characterizing the imminence of a close approach between two vessels.		✓		The CSOC allow track warnings of collision prediction, based on CPA and TCPA. However, the observation and interview showed either no utilization or absence of this decision support function (DSF) during the operation.
2	Anchor Watch Anchor watch should alert a VTSO that an anchored ship has drifted beyond the safe limits of its defined anchorage.		✓		The CSOC allow track warning of dragging or dredging anchor, exceeding the assigned radius. However, the observation and interview showed either no utilization or absence of this decision support function (DSF) during the operation.

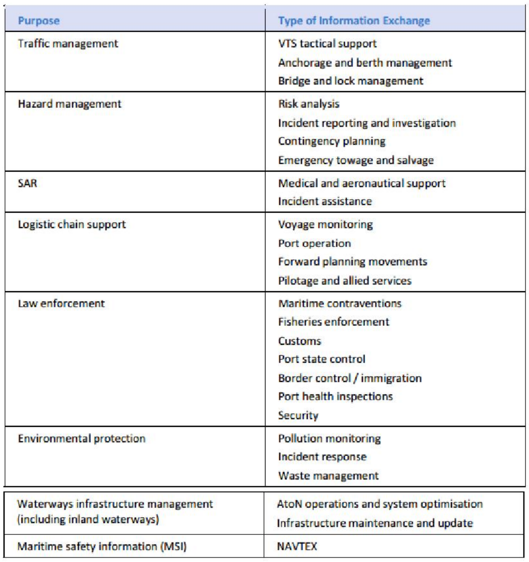
3	Grounding Avoidance A ground alarm requires details of the draught of the vessel, the bathymetry and tidal information. The alarm is raised if the estimated under-keel clearance along the predicted path of the vessel is less than a pre-defined threshold.		✓		The CSOC allow track warning of grounding prediction, based on the depth of area, the vessel draught, and the keel clearance within a predefined time limit. However, the observation and interview showed either no utilization or absence of this decision support function (DSF) during the operation.
4	Air Draught Clearance Air Draught is an alarm that requires the air draught of the vessel, the obstacle clearance, bathymetry and tidal information. The alarm is raised if the estimated clearance is less than a threshold.			✓	There was no track warning for predicting air draught clearance through the manual of the CSOC.
5	Sailing Plan Compliance Sailing Plan Compliance warns VTSOs when a ship's track is outside of the route spatial or temporal boundaries that have been defined for that specific ship.		✓		There was no track warning for the compliance of sailing plan . However, there is a warning for navigation channel that might be used, which is when an assigned track is deviating from the allowed course in that element of the channel. However, the observation and interview showed either no utilization or absence of this decision support function (DSF) during the operation.
6	Area Related These warn the VTSO that a ship has, or is about to, penetrate a pre-defined area or cross a pre-defined navigational line.		✓		The CSOC allow track warning of multipurpose area approach, based on the detected approach watch area and within the defined time limit. However, the observation and interview showed either no utilization or absence of this decision support function (DSF) during the operation.
7	Speed Limitations These warns VTSOs whenever a ship's speed is outside pre-defined speed boundaries (SOG).	✓			The CSOC allow track warning of multipurpose area speed high, whenever the maximum speed for that area is exceeded. Nevertheless, there is no regulated speed limit in the area of Merak VTS. For a while,

					therefore, it seems like this DSF is not necessary.
8	Incident or Accident Management Where the VTS is tasked to support the Incident Management, Decision Support Tool could help visualize and plan the allocation of resources within the incident area.		✓		The CSOC has additional service to receive and distribute data from a search and rescue application, namely C-Scope Incident Management. However, the observation and interview showed either no utilization or absence of this decision support function (DSF) during the operation.

External Information Exchange	Yes		No	Existing Condition
	Fully	Partially	Not at all	
Characteristics of External Information Exchange in VTS				
VTSs can be considered focal points for data since they integrate data from various sources (for example, AIS, radar) for their day-to-day operation. This data may be shared with parties outside of VTS where there is an operational need.				
Information Exchange Between VTS and Vessel 	✓			The information has to be reported, and procedure to be followed by VTS are written in #2.1.1, #2.1.3, #3.1.2, #3.1.7, #3.1.8, #3.2.1, and #3.2.2 SOP of Merak VTS, meanwhile the information to be reported by vessels are written in #3.1.1 and #3.1.6 SOP of Merak VTS. From the observation and interview, the information exchange with the vessels has been very well established and following the mentioned purpose in the table. Nevertheless, sometimes, a few types of information exchange were skipped to be

Purpose	Type of Information Exchange
General information exchange	Risk identification and avoidance Monitoring of cargo, vessel status and resources Voyage planning and execution (e.g. under keel clearance and track keeping) Meteorology and hydrography Cargo management (planning, loading and discharging) Logistics support (shipboard)
Regulatory Compliance	Reporting Environmental protection
SAR response (pending individual VTS responsibilities)	Medical and aeronautical support Incident assistance

<table>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>established, such as cargo management and environmental protection.</td>
</tr>
<tr>
<td>
Information Exchange Between VTS and Shore-based Entities



<table>
<tr><th>Purpose</th><th>Type of Information Exchange</th></tr>
<tr><td>Traffic management</td><td>VTS tactical support
Anchorage and berth management
Bridge and lock management</td></tr>
<tr><td>Hazard management</td><td>Risk analysis
Incident reporting and investigation
Contingency planning
Emergency towage and salvage</td></tr>
<tr><td>SAR</td><td>Medical and aeronautical support
Incident assistance</td></tr>
<tr><td>Logistic chain support</td><td>Voyage monitoring
Port operation
Forward planning movements
Pilotage and allied services</td></tr>
<tr><td>Law enforcement</td><td>Maritime contraventions
Fisheries enforcement
Customs
Port state control
Border control / immigration
Port health inspections
Security</td></tr>
<tr><td>Environmental protection</td><td>Pollution monitoring
Incident response
Waste management</td></tr>
<tr><td>Waterways infrastructure management (including inland waterways)</td><td>AtoN operations and system optimisation
Infrastructure maintenance and update</td></tr>
<tr><td>Maritime safety information (MSI)</td><td>NAVTEX</td></tr>
</table>
</td>
<td></td>
<td>✓</td>
<td></td>
<td>Based on the #2.1.2 SOP of Merak VTS, the allied services are port state control, port company, sea and coast guard, water police, Navy, SAR team, a port operator and ship agent.
From the observation and interview, the information exchange with the shore-based entities has been well established and in accordance with the mentioned purposes in the table. Moreover, procedures related to regulatory non-compliance, incident and pollution, and special operation to be followed by VTS are written in #3.2.1 and #3.2.2 SOP of Merak VTS.
However, the purpose for the environmental protection was still in low level and several types of information exchange have not yet established, such as berth management, fisheries enforcement, pollution monitoring, as well as the waste management.</td>
</tr>
</table>

Verification and Validation		Yes		No	Existing Condition
		Fully	Partially	Not at all	
The performance of VTS equipment should be verified prior to operation. This may include the following verification activities :					According to the manual of VTS equipment installed in Merak VTS, they had been verified prior to the operation. It is to mention the design and the compatibility with valid safety regulations, all relevant international standards such as IEC and ITU, EC certificate of conformity or CE declaration of conformity. Some of them have type approval certificates from major classification societies or major oil companies. All sensors are factory calibrated or tested and delivered with a calibration certificate or left the factory with a factory test report in perfect technical and safe relevant condition.
1	Type approval of individual equipment, as required by law in individual countries.	✓			
2	other equipment specific verification tests as required by the individual VTS Authority.	✓			
3	verification of equipment prior to delivery in the form of Factory Acceptance Tests (FAT).	✓			
Acceptance Testing					
1	The Acceptance Test Plan (ATP).	✓			
2	Factory Acceptance Test (FAT).	✓			
3	Installation and Site Acceptance Test (SAT).	✓			

Human Element's Aspects

Core Operational and Technical Requirements		Yes		No	Existing Condition
		Fully	Partially	Not at all	
Establishing The Requirements for a VTS System (Operational Requirement)					
The operational requirements needed to derive the system concept and technical requirements should consider:					
1	human factors including health and safety issues.	✓			Written in the #1.1.2, #1.1.3 and #2.1.2 SOP of Merak VTS.
2	tasks to be performed by System users.		✓		Has been established

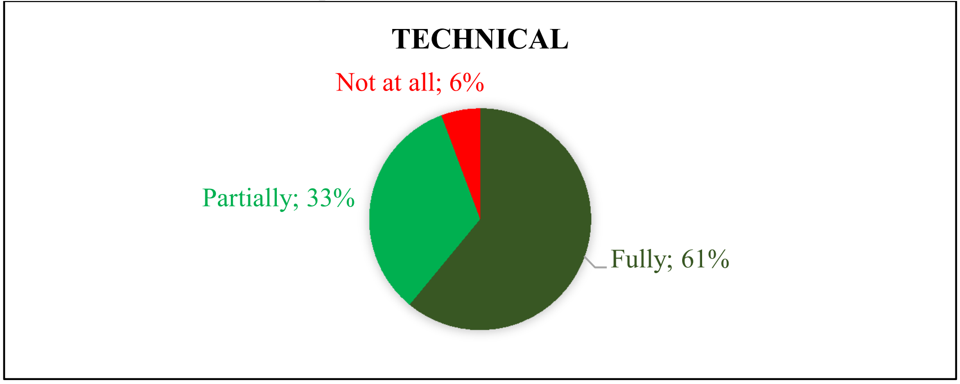
Administrative Works' Aspects

Core Operational and Technical Requirements		Yes		No	Existing Condition
		Fully	Partially	Not at all	
Establishing The Requirements for a VTS System (Operational Requirement)					
The operational requirements needed to derive the system concept and technical requirements should consider:					

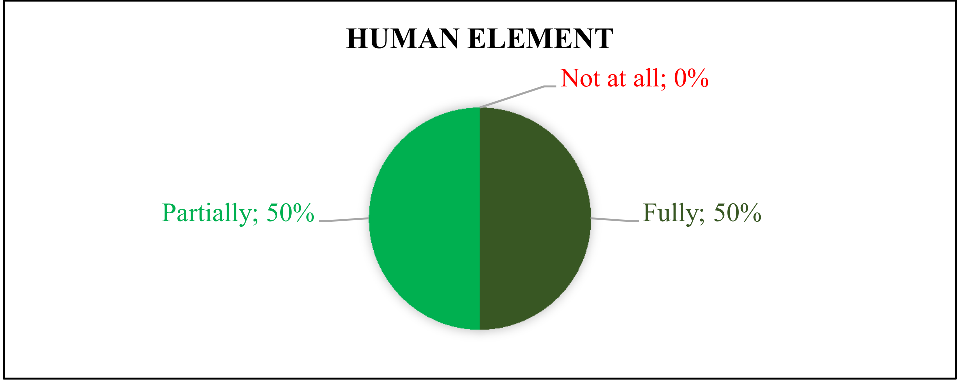
1	delineating the VTS area and, if appropriate, VTS sub-areas or sectors.	✓			The area boundaries are clearly set.
2	type of services to be provided (INS, TOS, NAS)		✓		INS is provided.
3	types and sizes of vessels which are required or expected to participate in the VTS.		✓		New regulation by Regulation from PM 88/2014. The allowance of vessel size is a minimum of 5.000 GT.
4	navigational hazards and traffic patterns		✓		Has been monitored
Operational procedures, staffing level and operating hours of the VTS					
1	co-operation with external stakeholders		✓		Has been done but not satisfied, such as with SAR, police, and pilot.
2	physical security of the VTS Centre and remote sites		✓		The environment around the VTS building is kept clean, and there is a security officer.
3	business continuity, availability, reliability and disaster recovery		✓		The procedures in case of emergency have been stated in #2.3.1, #3.2.1 and #3.2.2 SOP of Merak VTS.
4	legal framework		✓		The SOP of Merak VTS exists. Last updated is on June 2015.

From the current list of IALA Guideline 1111, this guideline has 12 sections for Technical Aspects, 1 section for Human Element Aspects, and 1 section for Administrative Works Aspects. Based on the student's finding and several assumptions on the items' lists, and with regards to the detailed Yes/No Question, the fulfillment percentage of each aspect can be measured, as follows:

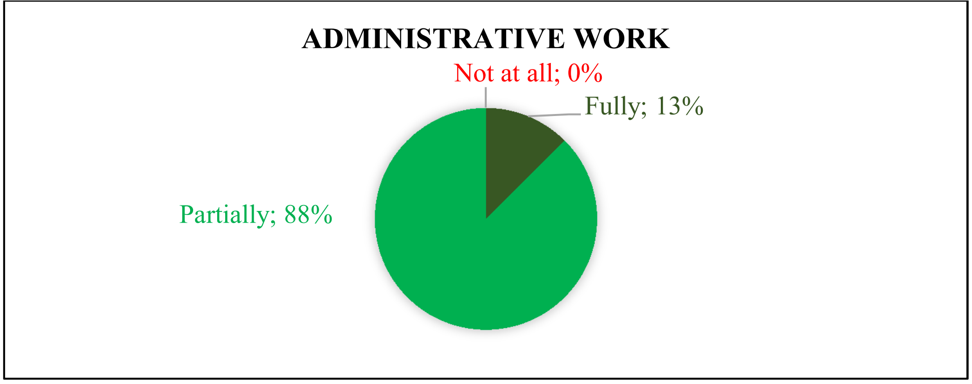
Technical's Aspect – covers 92% of all items in this resolution



Human Element's Aspect – covers 2% of all items in this resolution



Administrative Works' Aspect – covers 6% of all items in this resolution



Note: Score of 100% defines that the particular aspect has been entirely in accordance with IALA Guideline 1111 in this preliminary study.

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APPENDIX B: Participants Consent Form

OPTIMIZATION VESSEL TRAFFIC SERVICES – A COMPARING CASE STUDY OF MERAK VTS IN SUNDA STRAIT INDONESIA AND WARNEMÜNDE VTS IN BALTIC SEA GERMANY

Formulir Persetujuan Menjadi Responden

Peran Peserta

Penelitian Skripsi ini adalah sebagai pemenuhan syarat meraih gelar Sarjana Teknik (S.T) di Institut Teknologi Sepuluh Nopember dan gelar Bachelor of Engineering (B.Eng) di Hochschule Wismar. Penelitian ini bermaksud untuk melakukan studi penerapan VTS di Selat Sunda dan di Laut Baltik sebagai layanan jasa yang dapat memastikan bahwa lalu lintas kapal berlangsung dengan aman dan efektif. Peserta akan lebih banyak dilibatkan dalam wawancara terkait prosedur operasional dan skema pelatihan bagi personel SDM VTS untuk membantu saya dalam mengumpulkan data studi ini.

Partisipasi Kerahasiaan Data

Jika Anda setuju untuk berpartisipasi, perlu diketahui bahwa partisipasi tidak wajib dan Anda bebas menarik diri dari studi kapanpun. Data yang dikumpulkan untuk penelitian akan diperlakukan sebagai rahasia. Selain itu, anonimitas semua peserta akan dipertahankan. Wawancara akan dilakukan dengan pertanyaan semi-terstruktur melalui wawancara tatap muka atau media telefon. Saya, Gianiti Claresta, atau Institut Teknologi Sepuluh Nopember atau Hochschule Wismar, dapat menyimpan data yang dikumpulkan dalam wawancara hingga satu tahun sejak pengerjaan skripsi selesai. Peserta tidak akan dibayar untuk berpartisipasi dalam wawancara ini. Tidak ada risiko cedera fisik atau emosional yang diantisipasi.

Pernyataan Persetujuan

Saya telah membaca dan memahami informasi di atas dan saya setuju untuk mengambil bagian dalam penelitian ini. Melalui persetujuan ini, saya mengizinkan data pribadi saya, sebagaimana yang disampaikan dalam wawancara, digunakan dalam penelitian ini. Saya mengerti bahwa semua data pribadi yang berkaitan dengan kesukarelaan disimpan dan diproses dengan sangat rahasia.

Participants Consent Form

The role of the participant

This bachelor thesis is in partial fulfillment of the award requirements for the degree of Sarjana Teknik (S.T) at the Institut Teknologi Sepuluh Nopember and the degree of Bachelor of Engineering (B.Eng) at the Hochschule Wismar. The study intends to do a comparing case study of VTS implementation in Sunda Strait and Baltic Sea as a tool that can ensure safe and effective traffic movement within the area. Participants will be engaged in interviews about the operational procedure and training scheme for human element of the VTS to help me collect data for this study.

Participation and Confidentiality of data

Should you agree to participate, be informed that participation is not obligatory and you are free to withdraw from the study at any point you may wish to do so. The data gather for the investigation will be treated as confidential. In addition, anonymity of all respondents will be preserved. The interviews will be conducted with semi-structured questions through face-to-face or phone interviews. I, Gianiti Claresta, or Institut Teknologi Sepuluh Nopember or Hochschule Wismar may retain the data gather in the interviews for up to one year after the completion of the study. Participants will not be paid for participating in these interviews. There is no anticipated risk of physical or emotional injury.

Consent Statement

I have read and understood the information and I agree to take part in the study. By this agreement, I consent to my personal data, as stated in the interview, being used for this study. I understand that all personal data relating to volunteers is held and processed in the strictest confidence.

Nama Lengkap Peserta / *Participant's Name*

....

Tempat, tanggal / *Place, date*: ....

Tanda Tangan / *Signature*

....

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APPENDIX C: Questionnaire

The implementation of operational procedure and training scheme for human element to ensure safe and efficient navigation in Merak VTS

VTS Operators

*Mandatory

Demographic Questions

1. **What is your age?***

   ....

2. **How many years have you been working as VTS Operator?***

   ....

3. **What is your background?***
   - ☐ Mariner
   - ☐ Indonesian Civil Service
   - ☐ Other: ....
4. **How many years have you worked in this profession?**

   ....

5. **What is your structural role/position at that time?**
   - ☐ Captain
   - ☐ Chief Officer
   - ☐ Civil Servant Echelon II B
   - ☐ Civil Servant Echelon II A
   - ☐ Other: ....
6. **What is your latest education?**
   - ☐ Maritime Academy
   - ☐ Vocational High School
   - ☐ High School
   - ☐ Diploma
   - ☐ Bachelor
   - ☐ Other: ....

SECTION I : **Technical Questions**

7. **Which of these equipments do you have to support monitoring and communication of navigation in your area? If yes, how frequently do you use them? *(Please provide each answer with circle)****

		Availability	Frequency
a.	X-Band Radar	Yes / No	Seldom / Sometimes / Often / Always
b.	S-Band Radar	Yes / No	Seldom / Sometimes / Often / Always
c.	AIS	Yes / No	Seldom / Sometimes / Often / Always
d.	CCTV	Yes / No	Seldom / Sometimes / Often / Always
e.	Meteorology Sensor	Yes / No	Seldom / Sometimes / Often / Always
f.	VHF Radiocommunication	Yes / No	Seldom / Sometimes / Often / Always
g.	Others? *(Please fill in by yourself)*		
	....		Seldom / Sometimes / Often / Always
	....		Seldom / Sometimes / Often / Always
	....		Seldom / Sometimes / Often / Always

Operational Questions

8. **Due to high traffic density, can you mention approximately how busy is your area within certain period of time?**
(e.g. 130-150 ships/passages a day, in holiday up to 41 ships a day, or 53.000 trip a year, etc.)*
....
....
....

9. **Do you manage communication with fishing vessels, yachts, and other small vessels?**
(Small vessel is any vessel who has tonnage less than 300 GT, length less than 30 meter, which has installed AIS on board)
   - ☐ Yes
   - ☐ No
   - ☐ Other: ....

10. **At most of the time, are ships the first one who start establishing communication with VTS?**
    - ☐ Yes
    - ☐ No
    - ☐ Other: ....

11. **The voluntarily Ship Reporting System is implemented in Merak VTS.**
Do ships call VTS at the time they enter the navigational area of Merak VTS?
    - ☐ Yes
    - ☐ No
    - ☐ Other: ....

12. **Who is more likely to make a call when entering the navigational area of Merak VTS?**
    - ☐ International sea going vessel
    - ☐ Domestic sea going vessel
    - ☐ Other: ....

13. **Have you experienced ships who are very reluctant and have never report anything to VTS?**
    - ☐ Yes
    - ☐ No

14. **Do you often experienced this kind of situation?**
    - ☐ Yes
    - ☐ No

15. **Do you keep your designated radio frequencies when doing continuous listening watch?**
    - ☐ Yes
    - ☐ No
    - ☐ Other: ....

16. **Are you used to make DSC (Digital Selective Calling) when ships is difficult to be reached?**
    - ☐ Yes
    - ☐ No
    - ☐ Other: ....

17. **Do you regularly broadcast informations to mariners in a day? (Information by means of weather forecast, traffic situation, precautionary areas, etc.)**
    - ☐ Yes
    - ☐ No
    - ☐ Other: ....

18. **In what kind of situation it is deemed necessary by VTS to escalate monitoring/communication? *(e.g. when ships are likely to have collision- encounter one another or overpass the CPA limit of 1 NM, when a vessel request to do so, when there is ongoing offshore pipeline installation, or other)****

    ....

    ....

    ....

19. **Which publication(s) has been provided to enable mariners with full details of valid requirements and procedures in Merak VTS area?***
    - ☐ Tide Tables
    - ☐ List of Ship Stations
    - ☐ Notices to Mariners
    - ☐ “World VTS Guide”
    - ☐ Other: ....

20. **Is there any speed limit for vessels when sailing through Sunda Strait and entering the coverage area of Merak VTS? If yes, how many knots?***
    - ☐ Yes – speed limit is/are .... knots
    - ☐ No

21. **Will there be any enforcement or fine charged to ships when they are non-compliant with VTS regulatory requirements?***
    - ☐ Yes
    - ☐ No
    - ☐ Other: ....

22. **Could you mention what enforcement action has been taken up till now against breach of navigation?**

    ....

    ....

    ....

Questions related to Emergency Situation

23. **Have you ever experienced a situation in your VTS, where a collision or dangerous encounter situation happened?***
    - ☐ Yes
    - ☐ No – Please go to question 26

24. **How often? How many situations do you remember?**
    - ☐ One
    - ☐ Two
    - ☐ Three or more

25. **Can you please shortly explain/sketch/describe one of those situations?**

    ....

    ....

    ....

    ....

Questions related to Internal and External Coordination

26. **In case of emergency or accident, are there any parties to be contacted by VTS?**
    - ☐ Yes
    - ☐ No
27. **Are most of co-ordinations with them done cooperatively, right in time, and so the possible danger or accident can be minimized or prevented?**
    - ☐ Yes
    - ☐ No
    - ☐ Other: ....
28. **What are the Allied Services of Merak VTS and how is the coordination?** ***For instance the Allied Service (Port Authority, SAR, etc.) and Port Community (including government agencies such as coastguards, customs, shipping companies, ASDP ferry company, etc.)**** *

    ....
    ....
    ....
29. **Do you manage to have routine communication within other VTS Centres in terms of sharing vessels information or other related navigations?***
    - ☐ Yes
    - ☐ No
    - ☐ Other: ....

Questions related to Role and Contribution of VTS

30. **Do you divide the VTS area into sub-areas or sectors?**
    - ☐ Yes
    - ☐ No
31. **In your opinion, what would be the pros, cons, or obstacles, in actualizing TSS? What facilities or equipments could possibly installed?**

    ....
    ....
    ....
32. **Overall, do you feel confident, satisfied with the implementation of your VTS?***
    - ☐ Yes
    - ☐ No

    Your personal remarks (optional): ....
33. **Based on your experience, do the existence of Merak VTS create safer and more efficient navigation in Sunda Strait area?***
    - ☐ Yes
    - ☐ No
    - ☐ Other: ....
34. **a) What changes has VTS given to Sunda Strait area?***

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Less fire/explosion	☐	☐	☐	☐	☐
Less grounding	☐	☐	☐	☐	☐
Less collision of 2 vessels	☐	☐	☐	☐	☐
Less casualties (man overboard, etc.)	☐	☐	☐	☐	☐
Less contact (hit fixed objects at sea)	☐	☐	☐	☐	☐
Less hazard to environment	☐	☐	☐	☐	☐

More effective in time (anchorage, pilotage, berthing)	☐	☐	☐	☐	☐

Others? *(Please fill in by yourself)*

....

b) Can you mention what is the most increasing performance for navigation since Merak VTS has been implemented? *(e.g. since 2016, collisions between ships has been decreased by 30% each year)** *

....
....
....

35. Is there any equipment, system, or coordination that you want to have available or be enhanced in your traffic monitoring operation?*

....
....
....

SECTION II : **Human Element Questions**

36. Do you have participated/currently participating in a training which relates to navigation or VTS?*

- ☐ Yes
- ☐ No – Please go to question 43

37. When did you take the first training?

- ☐ Before or when about to work as VTS Operator
- ☐ When or after work as VTS Operator

38. Which level of training(s) have you participated in? *(You can choose more than 1)*

- ☐ VTS Operators Basic Training (V-103/1)
- ☐ VTS Supervisor – Advancement Training (V-103/2)
- ☐ VTS On The Job Training (V-103/3)
- ☐ VTS On The Job Instructor (V-103/4)
- ☐ VTS Revalidation (Reccurent/Adaption/Updating) (V-103/5)
- ☐ GMDSS General Operator’s Certificate (GOC)
- ☐ Other: ....

39. Can you mention name of institution who has provided you with these trainings?

....
....

40. When did you had your last VTS training course?

- ☐ More than one year ago
- ☐ During the last year
- ☐ During last half year
- ☐ Other: ....

41. Do you think the training you participated in is beneficial?

- ☐ Yes
- ☐ No
- ☐ Other: ....

42. Do you believe that you have have adequate training to perform your tasks as VTS Operator?

- ☐ Yes
- ☐ No
- ☐ Other: ....

43. Are you experiencing confusion or intense stress if emergency navigational situations happened?

☐ Yes
☐ No

44. Does continuously growing work pressure affect you?

☐ Yes
☐ No

45. Do you feel like you need to take refresher/further course for sharpening the necessary skills and knowledge to be performed?

☐ Yes
☐ No
☐ Other: ....

46. Are your daily work hours often more than 9?

☐ Yes
☐ No

47. Do you have enough time to do short break during your work hours?

☐ Yes
☐ No

48. Do you feel tired and sleepy at work?

☐ Yes
☐ No

49. Does continuous listening watch in a team always be accompanied by VTS Supervisor?

☐ Yes
☐ No

50. Do you prefer to have more VTS operators available in a team?

☐ Yes
☐ No

51. Do you believe your working area is safe?

☐ Yes
☐ No

52. Do you have any suggestions or ideas for improvement of training, working hours, staffing level, or any other recruitment and qualifications in Merak VTS?*

....
....
....

SECTION III : **Administrative Work Questions**

53. Are you concerned about international regulation?

☐ Yes – Please continue to question 54.a)
☐ No – Please continue to question 54.b)

54. a) Could you describe what is your exact concern? Or do you have any expectations?

☐ The rules might not suitable to be implemented in my current sea area
☐ The rules are too strict and technical
☐ I wish to have more international collaboration
☐ I wish to take part in training/workshop
☐ Other: ....

b) May you please give a reason why?

☐ The rules are totally fine
☐ It does not concern me
☐ None

55. While we have mixture of national and international rules and regulations, how do you think about the current legal framework? Is there any operational procedure that you want to have available or enhance or delete during the operation?*

....
....
....

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APPENDIX D: Operational Procedures

D.1. Operational Procedures in Merak VTS –
(Surat Keputusan Direktur Jenderal Perhubungan Laut (NV. 101/1/8/DJPL.15): Pemberlakuan Standard Operasional Prosedur VTS Merak)

SECTION 1: Introduction
Procedure 1: General introduction, goal, purpose, and objective
Procedure 1.1: Operational coverage area in 1st phase (chart and coordinates), anchorage area, equipment, and provided services (VHF channel)
Procedure 1.1.1: Participating vessels for mandatory reporting system
- Mandatory participation
- Exception

Procedure 1.1.2: Responsibily VTS Staff
Procedure 1.1.3: Work duty, training, and certification VTS Staff
- Structural position
- Shifts
- Basic training
- OJT training

SECTION 2: Internal Procedure
Procedure 2.1.1: Communication (weather broadcast & traffic situation), coordination, logkeeping
Procedure 2.1.2: Communication with Allied services, Security, and Mass media
- Internal & external coordination
- Health, safety, security at the office
- Mass media

Procedure 2.1.3: Routine operation
- Before, during, and after work duty
- Maintenance of AtoN
- Broadcast of missing/misplace AtoN
- Local broadcast (notice to mariners prior to official version from Navigational District)
- Time of broadcast
- Monitoring of VHF, Radar, and AIS

Procedure 2.1.4: Routine tasks (work duty handover)
- Briefing
- Neighbouring VTS

Procedure 2.1.5: Routine tasks (correction and storage of chart and publications)
Procedure 2.2.1: Equipment operation (list of equipment)
Procedure 2.3.1: Routine communication
- Language

- SMCP
- Communication priority
- VHF channel guard

Procedure 2.4.1: Emergency internal situation

SECTION 3: External Procedure

Procedure 3.1.1: Arrival and departure of vessel in Ship Reporting area Sunda Strait (position of reporting & informations to be reported)

- Where; position of reporting
- What; informations to be reported
- Exception for ferry and Navy vessel

Procedure 3.1.2: INS service

- Consideration of monitoring
- Information delivered to vessel
- Time to deliver
- Message markers: Information, Advice, Instruction
- Non-compliance with instruction
- Monitoring of non-participating vessel with VTS

NAS service (can be provided when deemed necessary)

- Situations need NAS

Procedure 3.1.3: Ships sailing through VTS area
Procedure 3.1.4: Ships in achorage, ship to ship transfer, ship at port
Procedure 3.1.5: (blank)
Procedure 3.1.6: Report of pre-arrival and pre-departure

- Information to be reported
- When to report

Procedure 3.1.7: Non-routine operation (procedure, difficult communication, broadcast, deviation, pollution to environment)
Procedure 3.1.8: Rough weather procedure

- Visibility
- Strong wind

Procedure 3.1.9: ISPS Code
Procedure 3.2.1: Enforcement to non-compliance of recommended Rules, Regulations, or Procedures

- Record of non-compliance

Incident/accident Report

- Type of incident/accident
- Record of incident/accident
- Report to Command Centre GDST

Special Operation

- Special activities in the area

Procedure 3.2.2: Emergency situation at sea

- Procedure

D.2. Operational Procedures in Germany – (Verwaltungsvorschrift der Schifffahrtsverwaltung des Bundes (VV-WSV 2408): Betrieb der Verkehrszentrale)

Content

Section 8: Communication
§ 29 Conduction of Voice Radiotelephony (VHF-communication)
§ 30 VHF-Radio Communication in Case of particular/special/extraordinary Events

Section 9: Operability/Efficiency of Equipment
§ 31 Handling/Operation of Devices
§ 32 Handling of/ Operation case of Dysfunction/Malfunction

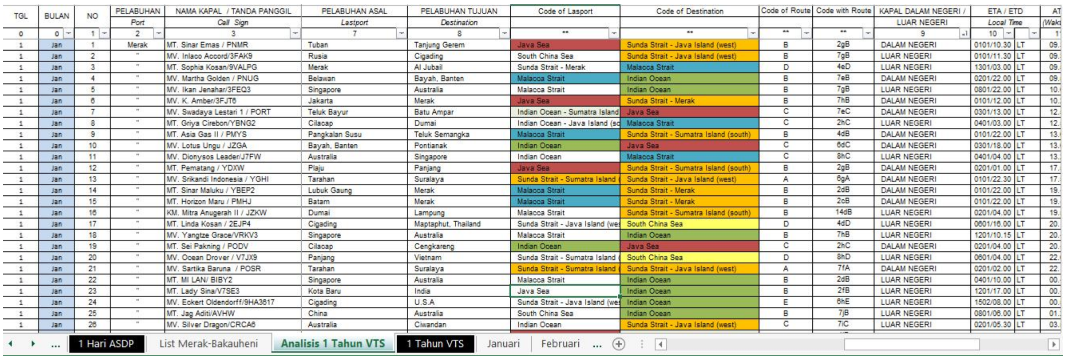
APPENDIX E: IWRAP of Sunda Strait

Note: Risk Assessment as listed in third sub-objective did not proceed from the study. This Appendix has the purpose of representing the mentioned progress as part of Chapter 5.4.

According to the Recommendation O-134 on the Risk Management Tool for Ports and Restricted Waterways, the IWRAP risk assessment process identifies major waterway safety hazards, estimates risk levels, evaluates potential mitigation measures, and sets the stage for implementation of selected measures to reduce risk to the required level.
The study has input the fleet data of vessels in Sunda Strait from AIS data of Merak VTS in 2017. At first, all daily data is collected and sorted to be a recapitulation of one-year fleet data. The data were completed with supporting data from www.marinetraffic.com. The necessary data to be input are static and dynamic data such as IMO Number, MMSI, Length, Speed, Last Port, and Destination Port.

TGL	BULAN	NO	PELABUHAN	NAMA KAPAL / TANDA PANGGIL	ID #	IMO	FLAG	AIS Vessel Type	Info of Type	iWRAP Ship Type	Code of Type	PANJANG	Code of Length	Code	KECEPATAN	
			Port	Call Sign	MMSI					(based on LR)		Length			Service Speed	Max Speed
0	0	1	2	3	4	**	**	**	**	**	**	**	**	**	**	**
1	Jan	1	Merak	MT. Sinar Emas / PNMR	525009063	9178238	Indonesia	Tanker	Oil Products Tanker	Oil products tanker	2	160	g	2g	11,2	12
1	Jan	2	"	MV. Inlaco Accord/3FAK9	357136000	9173018	Panama	Cargo	Bulk Carrier	Bulk carrier	7	153,5	g	7g	10,5	12,5
1	Jan	3	"	MT. Sophia Kosan/9VALPG	565843000	9374557	Singapore	Tanker - Hazard C (Minor)	LPG Tanker	Gas tanker	4	120,42	e	4e	14,3	17,4
1	Jan	4	"	MV. Martha Golden / PNUG	525012106	9118898	Indonesia	Cargo	Cement Carrier	Bulk carrier	7	117,31	e	7e	9,8	10,1
1	Jan	5	"	MV. Ikan Jenahar/3FEQ3	371360000	9426855	Panama	Cargo	Bulk Carrier	Bulk carrier	7	171,59	g	7g	6,2	6,9
1	Jan	6	"	MV. K. Amber/3FJT6	354183000	9586693	Panama	Cargo	Bulk Carrier	Bulk carrier	7	189,99	h	7h	10,9	12,2
1	Jan	7	"	MV. Swadaya Lestari 1 / PORT	525022093	9161522	Indonesia	Cargo	Cement Carrier	Bulk carrier	7	113,22	e	7e	13,2	13,3
1	Jan	8	"	MT. Griya Cirebon/YBNG2	525100126	9279587	Indonesia	Tanker	Oil Products Tanker	Oil products tanker	2	180	h	2h	9,6	11,1
1	Jan	9	"	MT. Asia Gas II / PMYS	525016500	9125401	Indonesia	Tanker - Hazard A (Major)	LPG Tanker	Gas tanker	4	93	d	4d	9	10,2
1	Jan	10	"	MV. Lotus Ungu / JZGA	525023216	8661769	Indonesia	Cargo	General Cargo	General cargo ship	6	92,08	d	6d	6,9	7,4
1	Jan	11	"	MV. Dionysos Leader/J7FW	432722000	9426350	Japan	Cargo	Vehicles Carrier	RoRo cargo ship	8	199,94	h	8h	16,2	18,5
1	Jan	12	"	MT. Pematang / YDXW	525008015	7825758	Indonesia	Tanker - Hazard B	Oil Products Tanker	Oil products tanker	2	158	g	2g	8,7	9,8
1	Jan	13	"	MV. Srikandi Indonesia / YGHI	526058852	9164823	Indonesia	Cargo	General Cargo	General cargo ship	6	157,9	g	6g	5,1	5,2
1	Jan	14	"	MT. Sinar Maluku / YBEP2	525009346	9297709	Indonesia	Tanker	Oil/Chemical Tanker	Oil products tanker	2	81	d	2d	11,4	12,2
1	Jan	15	"	MT. Horizon Maru / PMHJ	525016211	9048017	Indonesia	Tanker - Hazard A (Major)	Oil/Chemical Tanker	Oil products tanker	2	64,88	c	2c	7,8	9,1
1	Jan	16	"	KM. Mitra Anugerah II / JZKW	525006400	-	Indonesia	Other	Other	Other ship	14	83	d	14d	7,1	7,4
1	Jan	17	"	MT. Linda Kosan / 2EJP4	235085678	9525209	United Kingdom	Tanker	LPG Tanker	Gas tanker	4	99,96	d	4d	12	12,7
1	Jan	18	"	MV. Yangtze Grace/VRKV3	477813300	9584231	Hong Kong	Cargo	Bulk Carrier	Bulk carrier	7	179,9	h	7h	12,4	13,2
1	Jan	19	"	MT. Sei Pakning / PODV	525008069	9509891	Indonesia	Tanker - Hazard D (Recognizable)	Oil Products Tanker	Oil products tanker	2	180,03	h	2h	9,7	10,9
1	Jan	20	"	MV. Ocean Drover / V7JX9	538006122	9232852	Marshall Is	Cargo	Livestock Carrier	RoRo cargo ship	8	176,7	h	8h	15,4	17,3
1	Jan	21	"	MV. Sartika Baruna / POSR	525012201	9219898	Indonesia	Cargo	Self Discharging Bulk Carrier	Bulk carrier	7	141,4	f	7f	8,5	9,8
1	Jan	22	"	MT. MI LAN/ BIBY2	413378950	9342047	China	Tanker - Hazard B	Oil/Chemical Tanker	Oil products tanker	2	95,68	d	2d	8,9	9,6
1	Jan	23	"	MT. Lady Sina/V7SE3	538003631	9439369	Marshall Is	Tanker	Oil/Chemical Tanker	Oil products tanker	2	128,6	f	2f	12,8	13,8
1	Jan	24	"	MV. Eckert Oldendorff/9HA3617	229798000	9676591	Malta	Cargo	General Cargo	General cargo ship	6	179,99	h	6h	11,1	11,3
1	Jan	25	"	MT. Jag Aditi/AVHW	419000182	9478195	India	Cargo	Bulk Carrier	Bulk carrier	7	229	j	7j	10,7	12,5
1	Jan	26	"	MV. Silver Dragon/CRCA6	477415800	9364447	Hong Kong	Cargo	Bulk Carrier	Bulk carrier	7	225	i	7i	13,8	14,2

Sorted data (1) showing Date, Month, Port, Callsign, MMSI, IMO Number, AIS Vessel Type, iWRAP Ship Type, Code of Type, Length, Code of Length, and Speed



TGL	BULAN	NO	PELABUHAN	NAMA KAPAL / TANDA PANGGIL	PELABUHAN ASAL	PELABUHAN TUJUAN	Code of Lasport	Code of Destination	Code of Route	Code with Route	KAPAL DALAM NEGERI / LUAR NEGERI	ETA / ETD		AT
			Port	Call Sign	Lastport	Destination						Local Time		(Wakt
0	0	1	2	3	7	8	**	**	**	**	9	10		1
1	Jan	1	Merak	MT. Sinar Emas / PNMR	Tuban	Tanjung Gerem	Java Sea	Sunda Strait - Java Island (west)	B	2gB	DALAM NEGERI	0101/10.30	LT	09.
1	Jan	2	"	MV. Inlaco Accord/3FAK9	Rusia	Cigading	South China Sea	Sunda Strait - Java Island (west)	B	7gB	LUAR NEGERI	0101/11.30	LT	09.
1	Jan	3	"	MT. Sophia Kosan/9VALPG	Merak	Al Jubail	Sunda Strait - Merak	Malacca Strait	D	4eD	LUAR NEGERI	1301/03.00	LT	09.
1	Jan	4	"	MV. Martha Golden / PNUG	Belawan	Bayah, Banten	Malacca Strait	Indian Ocean	B	7eB	DALAM NEGERI	0201/22.00	LT	09.
1	Jan	5	"	MV. Ikan Jenahar/3FEQ3	Singapore	Australia	Malacca Strait	Indian Ocean	B	7gB	LUAR NEGERI	0801/22.00	LT	10.
1	Jan	6	"	MV. K. Amber/3FJT6	Jakarta	Merak	Java Sea	Sunda Strait - Merak	B	7hB	DALAM NEGERI	0101/12.00	LT	10.
1	Jan	7	"	MV. Swadaya Lestari 1 / PORT	Teluk Bayur	Batu Ampar	Indian Ocean - Sumatra Island	Java Sea	C	7eC	DALAM NEGERI	0301/13.00	LT	12.
1	Jan	8	"	MT. Griya Cirebon/YBNG2	Cilacap	Dumai	Indian Ocean - Java Island (so	Malacca Strait	C	2hC	LUAR NEGERI	0401/03.00	LT	12.
1	Jan	9	"	MT. Asia Gas II / PMYS	Pangkalan Susu	Teluk Semangka	Malacca Strait	Sunda Strait - Sumatra Island (south)	B	4dB	DALAM NEGERI	0101/22.00	LT	13.
1	Jan	10	"	MV. Lotus Ungu / JZGA	Bayah, Banten	Pontianak	Indian Ocean	Java Sea	C	6dC	DALAM NEGERI	0301/18.00	LT	13.
1	Jan	11	"	MV. Dionysos Leader/J7FW	Australia	Singapore	Indian Ocean	Malacca Strait	C	8hC	LUAR NEGERI	0401/04.00	LT	13.
1	Jan	12	"	MT. Pematang / YDXW	Plaju	Panjang	Java Sea	Sunda Strait - Sumatra Island (south)	B	2gB	DALAM NEGERI	0201/01.00	LT	17.
1	Jan	13	"	MV. Srikandi Indonesia / YGHI	Tarahan	Suralaya	Sunda Strait - Sumatra Island (	Sunda Strait - Java Island (west)	A	6gA	DALAM NEGERI	0101/22.30	LT	17.
1	Jan	14	"	MT. Sinar Maluku / YBEP2	Lubuk Gaung	Merak	Malacca Strait	Sunda Strait - Merak	B	2dB	DALAM NEGERI	0101/22.00	LT	19.
1	Jan	15	"	MT. Horizon Maru / PMHJ	Batam	Merak	Malacca Strait	Sunda Strait - Merak	B	2cB	DALAM NEGERI	0101/22.00	LT	19.
1	Jan	16	"	KM. Mitra Anugerah II / JZKW	Dumai	Lampung	Malacca Strait	Sunda Strait - Sumatra Island (south)	B	14dB	LUAR NEGERI	0201/04.00	LT	19.
1	Jan	17	"	MT. Linda Kosan / 2EJP4	Cigading	Maptaphut, Thailand	Sunda Strait - Java Island (wes	South China Sea	D	4dD	LUAR NEGERI	0601/16.00	LT	20.
1	Jan	18	"	MV. Yangtze Grace/VRKV3	Singapore	Australia	Malacca Strait	Indian Ocean	B	7hB	LUAR NEGERI	1201/10.15	LT	20.
1	Jan	19	"	MT. Sei Pakning / PODV	Cilacap	Cengkareng	Indian Ocean	Java Sea	C	2hC	DALAM NEGERI	0201/04.00	LT	20.
1	Jan	20	"	MV. Ocean Drover / V7JX9	Panjang	Vietnam	Sunda Strait - Sumatra Island (	South China Sea	D	8hD	LUAR NEGERI	0601/04.00	LT	22.
1	Jan	21	"	MV. Sartika Baruna / POSR	Tarahan	Suralaya	Sunda Strait - Sumatra Island (	Sunda Strait - Java Island (west)	A	7fA	DALAM NEGERI	0201/02.00	LT	22.
1	Jan	22	"	MT. MI LAN/ BIBY2	Singapore	Australia	Malacca Strait	Indian Ocean	B	2dB	LUAR NEGERI	0401/10.00	LT	00.
1	Jan	23	"	MT. Lady Sina/V7SE3	Kota Baru	India	Java Sea	Indian Ocean	B	2fB	LUAR NEGERI	1201/17.00	LT	00.
1	Jan	24	"	MV. Eckert Oldendorff/9HA3617	Cigading	U.S.A	Sunda Strait - Java Island (wes	Indian Ocean	E	6hE	LUAR NEGERI	1502/08.00	LT	00.
1	Jan	25	"	MT. Jag Aditi/AVHW	China	Australia	South China Sea	Indian Ocean	B	7jB	LUAR NEGERI	0801/06.00	LT	01.
1	Jan	26	"	MV. Silver Dragon/CRCA6	Australia	Ciwandan	Indian Ocean	Sunda Strait - Java Island (west)	C	7iC	LUAR NEGERI	0201/05.30	LT	03.

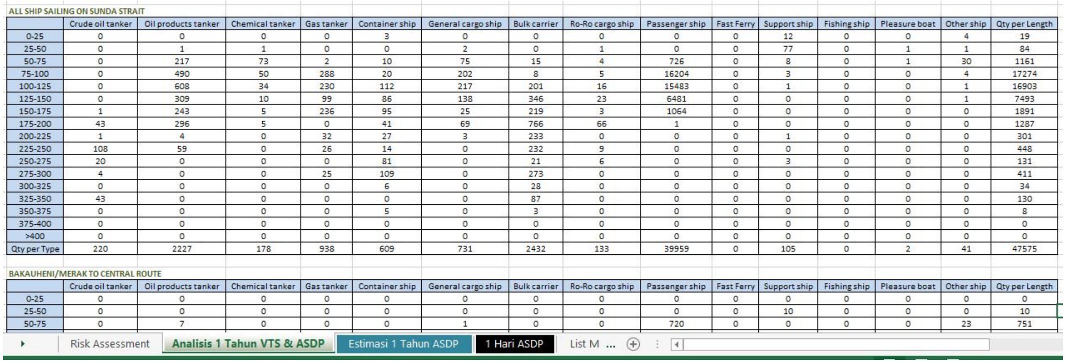
Sorted data (2) showing Date, Month, Port, Callsign, Lastport, Destination Port, and Code of Route

After that, the author sorted the route of each shipping fleet, becoming five scenarios, which are:

- Sunda Strait, whenever the ship was sailing from Sunda Strait areas such as Merak, Bakauheni, Cilegon, and other similar routes.
- Java Sea, whenever the ship was sailing through the Java Sea area such as Tanjung Priok, Kota Baru, Tanjung Perak, Samarinda, and other similar routes.

- Malacca Strait, whenever the ship was sailing from the area of Malaysia, Dumai, Singapore, and other similar routes.
- South China Sea, whenever the ship was sailing from China, Philippines, Rusia, and other far distant countries which has a probability of coming to Merak through the South China Sea.
- Indian Ocean, whenever the ship was sailing from Australia and other far distant countries which has a probability of coming to Merak through the Indian Ocean.

After finished up sort the data, the author needed to compile the data through the Risk Assessment Tool to obtain the risk frequencies, which is by using iWRAP. Since iWRAP needs several data to complete the formula, which are ship type, ship length, and its route, the author gave a code to each of clusterization. The amount of ship regarding its type and its length can be obtained as shown below.



ALL SHIP SAILING ON SUNDA STRAIT

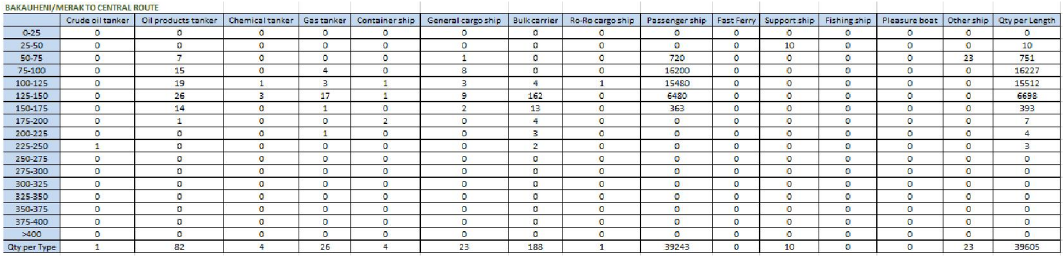
	Crude oil tanker	Oil products tanker	Chemical tanker	Gas tanker	Container ship	General cargo ship	Bulk carrier	Ro-Ro cargo ship	Passenger ship	Fast Ferry	Support ship	Fishing ship	Pleasure boat	Other ship	Qty per Length
0-25	0	0	0	0	3	0	0	0	0	0	12	0	0	4	19
25-50	0	1	1	0	0	2	0	1	0	0	77	0	1	1	84
50-75	0	217	73	2	10	75	15	4	726	0	8	0	1	30	1161
75-100	0	490	50	288	20	202	8	5	16204	0	3	0	0	4	17274
100-125	0	608	34	230	112	217	201	16	15483	0	1	0	0	1	16903
125-150	0	309	10	99	86	138	346	23	6481	0	0	0	0	1	7493
150-175	1	243	5	236	95	25	219	3	1064	0	0	0	0	0	1891
175-200	43	296	5	0	41	69	766	66	1	0	0	0	0	0	1287
200-225	1	4	0	32	27	3	233	0	0	0	1	0	0	0	301
225-250	108	59	0	26	14	0	232	9	0	0	0	0	0	0	448
250-275	20	0	0	0	81	0	21	6	0	0	3	0	0	0	131
275-300	4	0	0	25	109	0	273	0	0	0	0	0	0	0	411
300-325	0	0	0	0	6	0	28	0	0	0	0	0	0	0	34
325-350	43	0	0	0	0	0	87	0	0	0	0	0	0	0	130
350-375	0	0	0	0	5	0	3	0	0	0	0	0	0	0	8
375-400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Qty per Type	220	2227	178	938	609	731	2432	133	39959	0	105	0	2	41	47575

BAKAUHENI/MERAK TO CENTRAL ROUTE

	Crude oil tanker	Oil products tanker	Chemical tanker	Gas tanker	Container ship	General cargo ship	Bulk carrier	Ro-Ro cargo ship	Passenger ship	Fast Ferry	Support ship	Fishing ship	Pleasure boat	Other ship	Qty per Length
0-25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25-50	0	0	0	0	0	0	0	0	0	0	10	0	0	0	10
50-75	0	7	0	0	0	1	0	0	720	0	0	0	0	23	751

Recapitulation of all ships sailing in Sunda Strait area

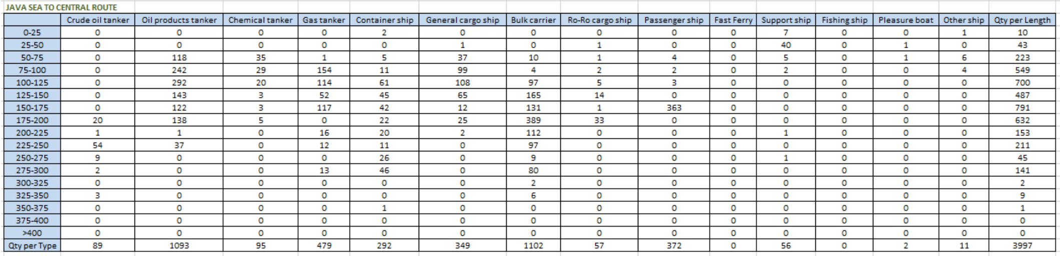
The next step is to define which data that will affect the Head-On Collision, which data which will afect the Overtaking Collision, as well as which data will affect Crossing Collision. The author decided to point all of them in the central point for projecting the scenario routes of the collision. Therefore, there are five tables created, which are:



BAKAUHENI/MERAK TO CENTRAL ROUTE

	Crude oil tanker	Oil products tanker	Chemical tanker	Gas tanker	Container ship	General cargo ship	Bulk carrier	Ro-Ro cargo ship	Passenger ship	Fast Ferry	Support ship	Fishing ship	Pleasure boat	Other ship	Qty per Length
0-25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25-50	0	0	0	0	0	0	0	0	0	0	10	0	0	0	10
50-75	0	7	0	0	0	1	0	0	720	0	0	0	0	23	751
75-100	0	15	0	4	0	8	0	0	16200	0	0	0	0	0	16227
100-125	0	19	1	3	1	3	4	1	15480	0	0	0	0	0	15512
125-150	0	26	3	17	1	9	162	0	6480	0	0	0	0	0	6698
150-175	0	14	0	1	0	2	13	0	363	0	0	0	0	0	393
175-200	0	1	0	0	2	0	4	0	0	0	0	0	0	0	7
200-225	0	0	0	1	0	0	3	0	0	0	0	0	0	0	4
225-250	1	0	0	0	0	0	2	0	0	0	0	0	0	0	3
250-275	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
275-300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
300-325	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
325-350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
350-375	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
375-400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Qty per Type	1	82	4	26	4	23	188	1	39243	0	10	0	0	23	39605

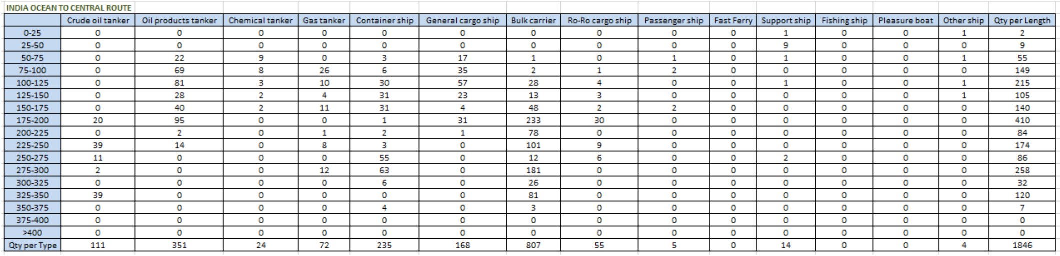
Density of Bakauheni/Merak to the Central Route (T1, T2)



JAVA SEA TO CENTRAL ROUTE

	Crude oil tanker	Oil products tanker	Chemical tanker	Gas tanker	Container ship	General cargo ship	Bulk carrier	Ro-Ro cargo ship	Passenger ship	Fast Ferry	Support ship	Fishing ship	Pleasure boat	Other ship	Qty per Length
0-25	0	0	0	0	2	0	0	0	0	0	7	0	0	1	10
25-50	0	0	0	0	0	1	0	1	0	0	40	0	1	0	43
50-75	0	118	35	1	5	37	10	1	4	0	5	0	1	6	223
75-100	0	242	29	154	11	99	4	2	2	0	2	0	0	4	549
100-125	0	292	20	114	61	108	97	5	3	0	0	0	0	0	700
125-150	0	143	3	52	45	65	165	14	0	0	0	0	0	0	487
150-175	0	122	3	117	42	12	131	1	363	0	0	0	0	0	791
175-200	20	138	5	0	22	25	389	33	0	0	0	0	0	0	632
200-225	1	1	0	16	20	2	112	0	0	0	1	0	0	0	153
225-250	54	37	0	12	11	0	97	0	0	0	0	0	0	0	211
250-275	9	0	0	0	26	0	9	0	0	0	1	0	0	0	45
275-300	2	0	0	13	46	0	80	0	0	0	0	0	0	0	141
300-325	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2
325-350	3	0	0	0	0	0	6	0	0	0	0	0	0	0	9
350-375	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
375-400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Qty per Type	89	1093	95	479	292	349	1102	57	372	0	56	0	2	11	3997

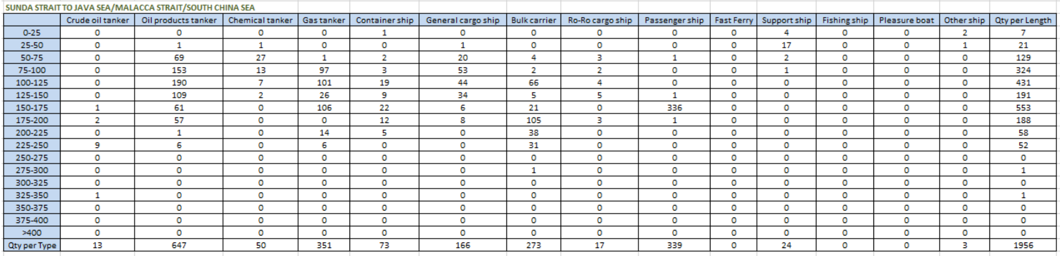
Density of Java Sea/Malacca Strait/South China Sea to the Central Route (T3)



INDIA OCEAN TO CENTRAL ROUTE

	Crude oil tanker	Oil products tanker	Chemical tanker	Gas tanker	Container ship	General cargo ship	Bulk carrier	Ro-Ro cargo ship	Passenger ship	Fast Ferry	Support ship	Fishing ship	Pleasure boat	Other ship	Qty per Length
0-25	0	0	0	0	0	0	0	0	0	0	1	0	0	1	2
25-50	0	0	0	0	0	0	0	0	0	0	9	0	0	0	9
50-75	0	22	9	0	3	17	1	0	1	0	1	0	0	1	55
75-100	0	69	8	26	6	35	2	1	2	0	0	0	0	0	149
100-125	0	81	3	10	30	57	28	4	0	0	1	0	0	1	215
125-150	0	28	2	4	31	23	13	3	0	0	0	0	0	1	105
150-175	0	40	2	11	31	4	48	2	2	0	0	0	0	0	140
175-200	20	95	0	0	1	31	233	30	0	0	0	0	0	0	410
200-225	0	2	0	1	2	1	78	0	0	0	0	0	0	0	84
225-250	39	14	0	8	3	0	101	9	0	0	0	0	0	0	174
250-275	11	0	0	0	55	0	12	6	0	0	2	0	0	0	86
275-300	2	0	0	12	63	0	181	0	0	0	0	0	0	0	258
300-325	0	0	0	0	6	0	26	0	0	0	0	0	0	0	32
325-350	39	0	0	0	0	0	81	0	0	0	0	0	0	0	120
350-375	0	0	0	0	4	0	3	0	0	0	0	0	0	0	7
375-400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Qty per Type	111	351	24	72	235	168	807	55	5	0	14	0	0	4	1846

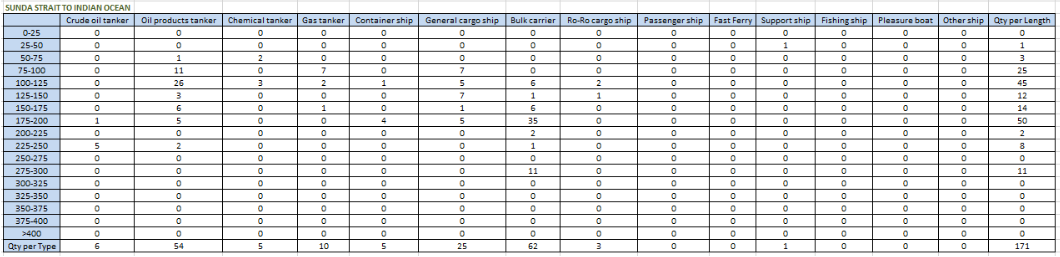
Density of Indian Ocean to the Central Route (T4)



SUNDA STRAIT TO JAVA SEA/MALACCA STRAIT/SOUTH CHINA SEA

	Crude oil tanker	Oil products tanker	Chemical tanker	Gas tanker	Container ship	General cargo ship	Bulk carrier	Ro-Ro cargo ship	Passenger ship	Fast Ferry	Support ship	Fishing ship	Pleasure boat	Other ship	Qty per Length
0-25	0	0	0	0	1	0	0	0	0	0	4	0	0	2	7
25-50	0	1	1	0	0	1	0	0	0	0	17	0	0	1	21
50-75	0	69	27	1	2	20	4	3	1	0	2	0	0	0	129
75-100	0	153	13	97	3	53	2	2	0	0	1	0	0	0	324
100-125	0	190	7	101	19	44	66	4	0	0	0	0	0	0	431
125-150	0	109	2	26	9	34	5	5	1	0	0	0	0	0	191
150-175	1	61	0	106	22	6	21	0	336	0	0	0	0	0	553
175-200	2	57	0	0	12	8	105	3	1	0	0	0	0	0	188
200-225	0	1	0	14	5	0	38	0	0	0	0	0	0	0	58
225-250	9	6	0	6	0	0	31	0	0	0	0	0	0	0	52
250-275	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
275-300	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
300-325	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
325-350	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
350-375	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
375-400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Qty per Type	13	647	50	351	73	166	273	17	339	0	24	0	0	3	1956

Density of Sunda Strait area to Java Sea/Malacca Strait/South China Sea (T5)



SUNDA STRAIT TO INDIAN OCEAN

	Crude oil tanker	Oil products tanker	Chemical tanker	Gas tanker	Container ship	General cargo ship	Bulk carrier	Ro-Ro cargo ship	Passenger ship	Fast Ferry	Support ship	Fishing ship	Pleasure boat	Other ship	Qty per Length
0-25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25-50	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
50-75	0	1	2	0	0	0	0	0	0	0	0	0	0	0	3
75-100	0	11	0	7	0	7	0	0	0	0	0	0	0	0	25
100-125	0	26	3	2	1	5	6	2	0	0	0	0	0	0	45
125-150	0	3	0	0	0	7	1	1	0	0	0	0	0	0	12
150-175	0	6	0	1	0	1	6	0	0	0	0	0	0	0	14
175-200	1	5	0	0	4	5	35	0	0	0	0	0	0	0	50
200-225	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2
225-250	5	2	0	0	0	0	1	0	0	0	0	0	0	0	8
250-275	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
275-300	0	0	0	0	0	0	11	0	0	0	0	0	0	0	11
300-325	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
325-350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
350-375	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
375-400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Qty per Type	6	54	5	10	5	25	62	3	0	0	1	0	0	0	171

Density of Sunda Strait area to Indian Ocean (T6)

After creating that clusterization, the author set the detail environmental condition of the route in Sunda Strait. Else that the data in density table above, other data needed to analyze head-on and overtaking frequency are such as length of leg, mean leg of ship ***i***, mean leg of the ship ***j***, the standard deviation of the ship ***i***, the standard deviation of ship ***j***. Meanwhile, for analyzing crossing collision frequency, the angle of ship collision of the ships ***i*** and ***j*** are also needed.

The input data could be projected, as shown below.

Descriptions	Value	Units
Length of leg	18878,35	m
Mean leg ***i***	75	m
Mean leg ***j***	75	m
Standard deviation leg ***i***	150	m
Standard deviation leg ***j***	150	m
Mean total	150	m
Standard deviation total	212,132	m
Angel table 3*	60	degree
Angel table 4*	120	degree

When the data is then processed into the software of IWRAP, the frequency of risk accident of head-on, overtaking, and crossing of ships sailing in Sunda Strait can be obtained. Due to the difficulties to access the licensed software, the data processing of this quantitative research could not be accomplished. As a substitute, the author was referring to the proposal of Indonesia to IMO in adopting Routeing Measures and Mandatory Ship Reporting System. The result is presented in Chapter 5.4. Meanwhile, the reference could be accessed in the List of Reference (IMO, 2017).

BIOGRAPHY OF AUTHOR

Gianiti Claresta is an undergraduate student in the Double Degree program of Marine Engineering Department at the Institut Teknologi Sepuluh Nopember and Hochschule Wismar and will be graduating in 2019 with a degree of Bachelor of Engineering. Claresta was an intern at PELINDO III Tanjung Perak Port in the division of port management and stevedoring process for one month, an intern at DUMAS Tanjung Perak Shipyard in quality assurance and quality control for one month, and a voluntary teacher at Serikat Sosial Vincentius Indonesia for an elementary student for one year. Claresta is the student member of IMarEST (SIMarEST) and actively participate in seminar and conference about management and maritime development. She had co-authored a presentation at Maritime Symposium, the Warnemünde Schiffahrtskolleg 2019, and intends to publish results in the university journal. During university years, she was the head organizer of university international project called ‘CommTECH Camp Insight’ for the course ship navigation safety and risk assessment of ship collision, a speaker and consultant for study abroad program of university international office, the head of public relation department at KMK ITS, and a manager of business development at AIESEC in Surabaya. Claresta has presently taken interests in navigational safety. Contact her at: clarestagianiti@gmail.com

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