Thailand VTS: an analysis of its capabilities to enhance the safety and efficiency of navigation

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THAILAND VTS: AN ANALYSIS OF ITS CAPABILITIES TO ENHANCE THE SAFETY AND EFFICIENCY OF NAVIGATION

By

THEERATCH AMPHANTHONGPAPHAKUL
Kingdom of Thailand

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

MASTER OF SCIENCE
In
MARITIME AFFAIRS
(SHIPPING MANAGEMENT AND LOGISTICS)

2018

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DECLARATION

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

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

(Signature): (Theeratch Amphanthongpaphakul)

(Date): 15th September 2018

Supervised by: Michael Baldauf, PhD (Dr. –Ing.)
Associate Professor
World Maritime University
DEDICATION

This dissertation is dedicated to the spirits of my life,
my grandparents, parents and brother
for their constant support and forbearance in the quest for this degree
ACKNOWLEDGEMENTS

Firstly, I would like to express my sincere gratitude to the Director General and Deputy-Director General of Marine Department of Thailand, Director of Maritime Safety and Environment Bureau, Director of Vessel Traffic Control and Maritime Security Office – Mr. Pitak Wattanapongpisal and Chief of Vessel Traffic Control Section – Mr. Thanatip Jantarakapde for nominating me for this unique opportunity to study at World Maritime University (WMU).

I thereafter would like to express my sincere gratitude to the chairperson of The Nippon Foundation – Mr. Yohei Sasakawa for his generosity in sponsoring me to study at WMU. I am also grateful to the Sasakawa Peace Foundation staff for their willingness and assistance.

My deep gratitude and recognition goes to my supervisor Associate Professor Dr. Michael Baldauf for his continuous support in supervising my dissertation and related research and for his patience, kindness, motivation and immense knowledge. His guidance helped me in all the time of research and writing of this dissertation.

I am very pleased to acknowledge the excellent assistance of all WMU Staffs. In addition, my thanks are also extended to my colleagues at WMU for their support, fun environment and warm friendship especially Thai friends.

Above all my deepest and most profound gratitude goes to my late father – Mr. Phisit Amphanthongpaphakul, my mother – Mrs. Thanida Amphanthongpaphakul and my brother – Mr. Ratchanon Amphanthongpaphakul together with grandparents and relatives for their inspiration, patience and support during the period of my absence. To them, I dedicate this dissertation.
ABSTRACT

Title of Dissertation: **Thailand VTS: An Analysis of its Capabilities to Enhance the Safety and Efficiency of Navigation**

Degree: **Master of Science**

Maritime safety and efficiency in Thailand has been seriously taken into consideration especially when focusing on the improvement of the national policy in the maritime sector towards the expansion of maritime transport. A VTS system has been installed to support such purpose and is considered as a new beginner in VTS implementation.

The purpose of this dissertation is to investigate the critical limitations and gaps of VTS implementation in Thailand that hold back the development of Thailand VTS. It also aims to determine the roles of Thailand VTS in enhancing the safety and efficiency of navigation and its ongoing situation.

A primary data collection is the semi-structure, in-depth interview, which is employed to collect the data from active VTS operators and relevant officials, who are highly experienced in the Thai context. The secondary data is obtained from the official documents and journals. These are used to support the findings and analyses correspondingly.

The study revealed that there are three identified gaps at Thailand VTS, which concern the quality of services. In addition, there are five main roles of Thailand VTS in terms of the capability to enhance the safety and efficiency of navigation. Finally, the study will present a set of recommendations, which hopefully would provide decisive actions to be taken for Thailand VTS.

**KEYWORDS:** VTS, IMO Guidelines, IALA standard, Thailand VTS
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<tr>
<td>CDEM</td>
<td>Construction, Design, Equipment, and Manning</td>
</tr>
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<td>EEZ</td>
<td>Exclusive Economic Zones</td>
</tr>
<tr>
<td>ETA</td>
<td>Estimated Time Arrival</td>
</tr>
<tr>
<td>GNSS</td>
<td>Global Navigation Satellite Systems</td>
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<tr>
<td>GOT</td>
<td>Gulf of Thailand</td>
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<td>GPRS</td>
<td>General Packet Radio Service</td>
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<td>GPS</td>
<td>Global Positioning Service</td>
</tr>
<tr>
<td>IALA</td>
<td>International Association of Marine Aids to Navigation and Lighthouse Authorities</td>
</tr>
<tr>
<td>IMCO</td>
<td>Inter-Governmental Maritime Consultative Organization</td>
</tr>
<tr>
<td>IMO</td>
<td>International Maritime Organization</td>
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<tr>
<td>INS</td>
<td>Information Service</td>
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<td>ISPS</td>
<td>International Ship and Port Facility Security Code</td>
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<tr>
<td>NAS</td>
<td>Navigational Assistance Service</td>
</tr>
<tr>
<td>NGO</td>
<td>Non-governmental Organization</td>
</tr>
<tr>
<td>RDF</td>
<td>Radar Detector Finder</td>
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<tr>
<td>SAR</td>
<td>Search and Rescue</td>
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<tr>
<td>SMCP</td>
<td>Standard Marine Communication Phrases</td>
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<td>SOLAS</td>
<td>International Convention for the Safety of Life at Sea</td>
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<tr>
<td>STCW</td>
<td>International Convention on Standards of Training, Certification and Watch keeping for Seafarers</td>
</tr>
<tr>
<td>Acronym</td>
<td>Full Form</td>
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<td>---------</td>
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<tr>
<td>TOS</td>
<td>Traffic Organization Service</td>
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<td>TSS</td>
<td>Traffic Separation Scheme</td>
</tr>
<tr>
<td>UNCTAD</td>
<td>United Nations Conference on Trade and Development</td>
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<tr>
<td>VHF</td>
<td>Very High Frequency</td>
</tr>
<tr>
<td>VTCMSO</td>
<td>Vessel Traffic Control and Maritime Security Office</td>
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<td>VTS</td>
<td>Vessel Traffic Services</td>
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<td>WMU</td>
<td>World Maritime University</td>
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CHAPTER 1
INTRODUCTION

This chapter presents a background of global VTS and VTS in Thailand (in-depth detail is presented in Chapter 2). Within this chapter, the problem statement, research objectives and research questions, scope of research, and dissertation outline are included.

1.1 Background to Global VTS

Maritime transportation has been one of the major modes of transport over the past centuries. It has supported not only the movement of goods and people but also the economic development and international business. At present, up to 90 percent by volume of global trade is carried on ships through seaports worldwide (UNCTAD, 2017). Thus, it can be said that without shipping, the globalized economy will have never been this sustainable.

According to the International Chamber of Shipping (2017), the shipping industry (seaborne trade) has observed a rise in a general trend. This has led to the necessity of the construction of vessels and the increase of merchant fleets. Nowadays, it is estimated that there are approximately 50,000 vessels registered by more than 150 maritime nations worldwide. By having the quantity of goods which are being transferred, the density of maritime traffic has also increased, for example with the change in size and technology (Wiersma, 2010).
As a result, the increase in cargo and traffic volume, as well as optimizing in logistics processes, the function of traffic monitoring and control is required in order to improve the efficiency and safety of operations. Therefore, in maritime transportation, the Vessel Traffic Services (VTS) is carried out in terms of traffic control in accordance with the definition provided by the International Maritime Organization (IMO) Resolution A.857(20) as:

“A service implemented by a Competent Authority, designed to improve the safety and efficiency of vessel traffic and to protect the environment. The service should have the capability to interact with the traffic and to respond to traffic situations developing in the VTS area.”

The VTS was first introduced in early 1948 when the first radar set was implemented in the Port of Liverpool – the world pioneer of the modern VTS (Hughes, 1998; Ustaoglu & Furusho, 2014). In principal, VTS provides comprehensive naval traffic information to ships consisting of three main services including information service (INS), traffic organization service (TOS), and navigational assistance service (NAS) (IALA, 2016). These are provided in order to ensure the safety and efficiency of navigation as well as the better protection of the marine environment. (Othman, 2004; IMO, 2018a)

In the early stage, after VTS was introduced, the International Maritime Organization (IMO) initially recognized the benefits of VTS in the Resolution A158 (ES.IV), known as the Recommendation on Port Advisory Systems (Marsden, Gault, Hazelwood & Tettenborn, 2003). Later on, when more advanced marine technologies were launched, IMO, then adopted guidelines for the effective planning and implementation of VTS, and other aspects such as standard requirements for personnel operating VTS covering recruitment, qualifications, and training protocols (Hughes, 1998).
Therefore, it is an encouragement that the competent authority is complying with the international guidelines and recommendations, based on readiness, to increase the interest in international harmonization and to improve maritime safety in order to strengthen the VTS’s value and the country’s competitiveness in the future.

1.2 Background to VTS in Thailand

The maritime safety and efficiency in Thailand has been seriously taken into consideration especially when the government of Thailand focused on the ongoing improvement of the national policy in maritime interest towards the expansion of maritime transportation.

In 1999, the cabinet mandated the Marine Department of Thailand, under the supervision of Ministry of Transport, to conduct the vessel traffic management and security control in Sriracha area, located in the upper Gulf of Thailand (GoT) as shown in figure 1, in order to enhance waterway safety and security such as traffic monitoring, controlling the incoming and outgoing vessels.

Subsequently, maritime traffic in the Gulf of Thailand (GoT) has gradually increased due to the expansion and strong development plan. The Marine Department of Thailand (2016) revealed that a significant number of vessels within a particular area has increased since 2007 until 2015. These included incoming vessels to the biggest ports of Thailand, Laemchabang Port and Bangkok port (Port Authority of Thailand, 2017).
In 2005, under the cabinet’s resolution, the Vessel Traffic Control and Maritime Security Office (VTCMSO) was established to control, monitor and facilitate maritime transportation as well as provide the traffic service at every port throughout the country. Several years later, in 2012, the first surveillance system, VTS Phase 1, was implemented in order to improve efficiency, safety and further contribute to the reduction of potential environmental pollution (Marine Department of Thailand, 2012).
Thus, the first VTS center was established in Sriracha, aiming to track the movement of vessels within 12 miles from coastal zone in order to prevent those vessels from, for example, unsafe naval zones, collision risks, and dragging of an anchor. The maritime communication is used between shore-side and vessels by broadcasting useful information. Moreover, the VTS center also functions as a supporter of any search and rescue mission twenty-four hours – seven days (24/7).

1.3 Problem Statement

Thailand considers itself as a beginner in using VTS. To conclude that, the successful implementation and application of VTS throughout these times seem to be too complicated because of the weakness particularly in application and operation. This is especially true when comparing to the international guidelines and manual as well as other developed neighboring countries where VTS is commonly used.

For this reason, it is assumed that the problems can be identified by both internal and external determinants. These include, for example, the ambiguous legal framework and operation measures, unqualified and inadequate VTS personnel together with other administrative issues. These problems possibly have a negative effect to not only for the users but it can also cause a number of undesired events such as accidents, crashes, losses of lives, and environmental pollution. In addition, the research in the VTS area, especially in the Thailand context, has been generally unexplored.

Therefore, this exploratory research aims to find out the remaining gaps that hold back the development and further develop the roles of Thailand VTS. The researcher believes that by comparing Thailand to other countries as well as using exploratory methods would come up with a proper catch-up policy for the future development of Thailand.
1.4 Research Objectives and Questions

(a) To perceive the roles of Thailand VTS in terms of its capabilities to enhance the safety and efficiency of navigation and the current ongoing situations;
(b) To explore Thailand VTS limitations and identify the gaps between Thailand VTS and the international guidelines/manuals;
(c) To propose a catch-up policy to improve the performance and reduce the identified remaining gaps.

In order to achieve the above objectives, the questions have been concluded in the study;

(a) What are the roles of Thailand VTS in terms of its capabilities to enhance the safety and efficiency of navigation and the current ongoing situations?
(b) What are the limitations and identified gaps remaining in Thailand VTS?
(c) How should Thailand VTS improve itself by bridging those gaps?

1.5 Scope of the Research

This research will focus on Sriracha VTS, Thailand. All samples are collected from Thai and international experts, who are experienced in the Thailand VTS contexts. Case studies of VTS in other countries, as well as the international guidelines/manuals adopted by IMO and IALA, is also conducted and discussed in order to allow the researcher to propose the catch-up policy to bridge the identified remaining gaps.
1.6 Dissertation Outline

In order to achieve the objectives of this dissertation, the research is divided and organized into the following chapters:

Chapter 1 presents the background of the research including background to global VTS and VTS in Thailand. These preliminary literatures are made to cover the better understanding of the problem from realistic perspective. Moreover, the research objectives and questions as well as scope are addressed within this chapter to point out the importance of the study.

Chapter 2 provides comprehensively in-depth literature review regarding the VTS development and its contributions. These include VTS development, definitions, functions and services, legal framework, IMO guidelines. Besides, VTS in Thailand in order to give a better understanding for Thailand.

Chapter 3 contains the research methodology and theoretical framework, which are the underlying principles of the research approach and investigation. This includes the nature of study, research design, data collection and procedure and data analyses. The ethical consideration is also addressed in this chapter.

Chapter 4 provides a summary of data analyses and research findings obtained within various data collections. It also highlights the critical limitation of VTS implementation in Thailand, while the gaps are also investigated.

Chapter 5 presents the interpretation of the results in light of the research questions and discussed in conjunction with the literature of VTS implementation in chapter 2.

Chapter 6 draws the research’s final conclusion on the topic within the dissertation. The final recommendations for Thailand VTS are also presented.
CHAPTER 2
LITERATURE REVIEW

Chapter 1 presented the overview of global VTS and VTS in Thailand, the problem statements, research objectives and questions. This chapter aims to present a review of the relevant in-depth literature for a more broadly based analysis of VTS. The chapter comprises of eight sections. The developments of VTS, VTS definition, VTS functions and services are presented in the first three sections in order to fully introduce the VTS context. The following sections explain the VTS legal framework and IMO guidelines, including VTS personnel, training and qualifications. These are found in sections four, five and six respectively, in order to highlight the international mechanism of VTS where interaction and harmonization are essential items. The VTS in Thailand is also included in section seven, while the chapter’s conclusion is drawn up last.

2.1 Development of VTS

Over centuries, cargoes have been transported by sea supporting trade worldwide. Transportation has increased the need for vessels to navigate safely and efficiently. For this reason, many authorities around the world have provided aids to navigation covering their coastal areas. The first fashion of aids to navigation were the shore-side beacons, followed by the introduction of buoys (IALA, 2016). Over the years, these tools have become better because of the developments and implementation of more enhanced and sophisticated technology, for example by the improvement of visibility, ranges, as well as audible signals.
However, especially after the Second World War, those developments were still insufficient to provide the full utilization of the facilities in the port. This was because of the complexity of traffic density and conditions of visibility. The meteorological conditions and congestion rise the delays of vessel traffic, causing the inefficacy of port operations (Wiersma, 2010).

According to Hughes (1998), there was a growing consensus that using shore-based radar with communication systems could produce efficiency, and enhance port safety. At that time, the first shore-based radar was implemented at Douglas, Isle of Man, in 1948, followed by the Port Liverpool and Rotterdam, where the radar set was installed as a Port Control station (Ustaoglu & Furusho, 2014).

Despite the fact that early systems aimed to reduce traffic delays and increase the flow of traffic efficiently in the beginning, a number of accidents were still high (Hughes, 1998). Then, the number of research projects were conducted to address the advantages of the system that help minimizing the accidents where radar surveillance is implemented. The conclusion was clear that providing such a system enables a port’s productivity and utilization. Furthermore, accident rates were lowered by 50 to 70 percent (Koburger, 1986: Le Blanc & Rucks, 1995: Hughes, 1998: Praetorius, Hollnagel & Dahlman, 2015).

In the late 1970s, the environmental issue brought attention to the world because of the results from shipping accidents. Major shipping accidents were, for instances, the Torrey Canyon, Amoco Cadiz and Metula (Koburger, 1986, p.5). Consequently, the authorities became aware and introduced numerous measures to enhance the safety of shipping and enlarge the operation of radar surveillance system as well as vessel traffic management. (IALA, 2016, p.13).
Nevertheless, IALA (2016) argued that moving further developments and using of the radar-aided traffic management had become controversial among authorities widely including the shipmasters and pilots. This was because the exercise of regulation over off-shore from shore-side was a new occurrence. It then turned out that it would become a necessity to harmonize VTS internationally.

After the VTS concept was widely recognized, Ustaoglu and Furusho (2014) explain that in 1968, the Inter-Governmental Maritime Consultative Organization (IMCO) (nowadays the IMO) adopted resolution A158 (ES.IV), also known as the Recommendation on Port Advisory Systems. It provided the recommendation to the authorities to establish VTS to enhance the safety based on the local conditions.

In 1985, IMO adopted Resolution A.578(14) – Guidelines for Vessel Traffic Services, to provide general rules of VTS planning and operational procedures (IMO, 2018a). However, it did not cover the liability for authorities to conduct the monitoring as well as the determination of the VTS operator’s recruitment, qualification and training.

The requirement of VTS has continuously developed over years. Especially after IMO updated its original guidelines and ultimately adopted the Resolution A.857 (20) – Guidelines for Vessel Traffic services in 1997. This guideline has apparently become the international recognition on VTS policy.

The advancement of technology was a dominant factor of the further development of VTS. It started from basic radars together with simple radio communication, which aimed to provide assistance for vessels in severe weather, to the new episode with sophisticated technology, for instance, multiple radar and communication sensors (Eriksen, Hoye, Narheim & Meland, 2006). It also focused on providing the maritime traffic organization and enhancing the safety of navigation while environmental protection was augmented.
It was clear that the rapid growth of transport, together with the situation involving exposure to danger such as potential environmental damage, collision of ships, traffic congestion required degree of instruments to deal with them (Mou, Zhou, Du & Tang, 2015). Hence, implementing VTS was the acknowledgement to deal with such situations. By implementing VTS, the international legislation in the maritime regime became evidently the new issue to be taken into consideration for future development.

At present, the competent authorities recognize widely the contribution of VTS, providing the principal goals in improving safe navigation, promoting the efficiency of port operations, and reducing the potential environmental pollution. As a result, there are more than 500 VTS centers implementing the systems worldwide (IALA, 2016).

2.2 VTS Definition

Over decades, there is increasing trend, in academic and industrial literatures, to use the definition of VTS. Although those meanings have been defined for decades, all are still ideal. Below are some model definitions;

Koburger (1986, p.5) defines VTS as: “A coherent, integrated assortment of personnel, operation procedures, equipment, and regulations, implemented by a competent authority, assembled for the purpose of marine traffic management in a given body of water.”

IMO (1997) gives the definition of VTS as: “A service implemented by a Competent Authority designed to improve the safety and efficiency of vessel traffic and to protect the environment. The service should have the capability to interact with the traffic and to respond to traffic situations developing in the VTS area.”
Another interesting description provided by Praetorius (2012, p.11) is: “A service implemented to enhance and promote the safety and fluency of the maritime traffic. VTS is provided by operators, located at VTS centres, who can offer information service, traffic organization service and navigational advice and assistance to all vessels in the determined VTS area”

It seems that these definitions have continuously developed. However, they have been evolved before twentieth century, which are quite old. The early definition provides only the simple elements of vessel traffic, while the modern definitions focus more on the purpose of vessel traffic management as well as functional elements.

Therefore, to conclude the definition, those descriptions provide important insights in VTS as a service, which deals with a collection, processing the data in order to provide the information for navigation. Its aims are to improve the safety of navigation, enhance traffic efficiency, as well as protecting potential environmental pollution. Furthermore, it encompasses personnel, regulations, procedures, organization and system comprehensively.

2.3 VTS Functions and Services

2.3.1 Types of VTS

In general, according to present IMO Guidelines, there are three main types of VTS which are Port or Harbour VTS, Coastal VTS and VTS in Inland Waters. These categories are based on the purpose of implementation, location and characteristic of the traffic specifically as follows:

(a) Port or Harbour VTS
The Port or Harbour VTS mostly deals with vessel traffic proceeding in and out of the port. Its purpose is to ensure the safety and efficiency mainly in the port area where
there is a high percentage of traffic congestion. According to Wennink (1992), Port or Harbour VTS involves in avoiding the delays of traffic. This is because it helps to reduce not only the potential accidents, but also promote the economic profitability of the port. Furthermore, it ensures the safety of human life and the better protection of marine environment.

(b) Coastal VTS
Coastal VTS is mainly concerned with facilitating the vessel for passing through the coastal waters or strait. The purpose is to provide safety of navigation and efficiency of traffic flow, security, as well as protecting the environment in particular area. In the coastal waters, it is more difficult because there are mostly marine sensitive areas and high traffic density. Therefore, Coastal VTS is more concerned with the legal issues, due to extending beyond the territorial waters of country (Mac William & Cooke, 2006).

(c) VTS in Inland Waters
The purpose of VTS in Inland Waters is similar to other types of VTS. The distinct aspect of this type is to provide a service within water banks, where the residents would have an impact from the water traffic. Inland waters can be rivers, lakes or places that are connected to the seawater by human or natural way.

2.3.2 Functions of VTS

According to IALA (2016), the VTS functions can be divided into two parts, consisting of internal and external functions. Internal functions concern the basic functions for VTS to perform the operational duties. To further explain, VTS receives information from various sources including navigational data, environmental data, ship data and traffic data. Those data will be analyzed, evaluated and followed by decision making before giving traffic services to the ships.
Meanwhile, external functions involve directly in the traffic characteristics, for example by monitoring the vessel traffic, regulating, and allocating the space over the area and other relevant management functions. Some examples are ancillary activities, and law enforcement. These can be considered as the daily routine of VTS duties.

To support those perspectives, Rattanasathien (1991) determines that the design of VTS functions is to support the vessel traffic. The main purpose is to provide the information to vessels frequently and precisely by performing as a traffic coordinator to make the flow of traffic movement and allocate the space in responsible area.

Figure 2: A general model of VTS, (Wiersma, 2010, p.23 (as cited in COST 301, 1987, p.57))

Figure 2 depicts the internal and external functions working jointly. The traffic scenario from external functions provide the information to internal functions as data collection, evaluation and decision making to related parties thereafter. This is true
when looking at the analysis of Hafez (1998), which supports the services provided to vessels from external functions of the VTS, while it is derived from internal functions as well.

Another model, figure 3, provided by Baldauf, M., et. al. (2018) supports the function of VTS that the data is transmitted to the vessels in order to provide the information, warning, advice and instruction. Data is analyzed and predicts the future by the VTS operator using the data collection including fairway, environmental conditions and traffic situation. Therefore, it is explicitly seen that the function of VTS are comprising the various elements, while they are working jointly.

![Functional model of VTS, Baldauf et. al., 2018a](image)

**Figure 3: The functional model of VTS, (Baldauf et. al., 2018a)**

### 2.3.3 Services of VTS

In principal, VTS provides three main services including Information Service (INS), Traffic Organization Service (TOS) and Navigational Assistance Service (NAS) as shown in figure 4. The level of those three services vary based on the decision of the VTS center (Praetorius, 2012).
According to IMO (1997), the Information Service (INS) gives information by broadcasting to the vessels navigating in the VTS responsible area. This information could be, for example, position, identity and destination of vessel, mandatory reporting procedures, meteorological conditions, visibility and other useful information. It also concerns the traffic image and responses to fulfill the management of traffic situations such as helping the vessel to make a broad decision for safe navigation.

![Figure 4: Type of services in VTS, (IALA, 2016)](image URL)
The Traffic Organization Service (TOS) is a service to manage the maritime traffic in the determined VTS area, especially in high traffic demand. Its aims are to provide the smooth flow of vessel traffic efficiently and safely and prevent the development of dangerous maritime traffic situations. Mostly, this service will be provided in a congested area such as port approaches or special area. By way of illustration, Othman (2004), and Praetorius (2012) gives examples of such a service as forming a traffic clearance, sailing plan, space allocation, mandatory report procedure, and designating speed limit zones. These means are organized in different measures to organize the maritime traffic accordingly.

Navigational Assistance Service (NAS) is a service to aid the decision-making process of personnel working onboard by giving important navigational information. Normally, this service will be provided only upon a vessel’s request or in a severe weather condition. The clear distinct between INS and NAS is that NAS is more likely involved in decision-making process actively. To illustrate, for example, the VTS operator provides NAS to personnel onboard by using VHF to forward the information about the position in a fairway and in case requested or observed to give advice on course and speed (MCA, 2009). However, VTS advice does not override the primary function of the onboard navigating team, which is to maintain safety at all time.

### 2.4 VTS Legal Framework

Despite the fact that authorities around the world have mostly recognized the benefits of VTS, there were still differences in term of the governance, which is based on local preparedness. Therefore, to avoid the confusion, an international agreement among the authorities is needed in order to provide harmonized interaction and operation of VTS at a global level. At the same time, the national or domestic legislations as well as regional regulation should be aligned to those agreements.
In general, numerous studies have attempted to clarify and to clearly explain the benefit of harmonization in maritime law and regulation as it will reduce the negative effects of diversity significantly. For example, Griggs (1998) explains that “The sea with its winds, storms danger doesn’t change; it calls for a necessary uniformity of juridical regimes”. In the same year, Stephan (1998) found that the harmonization of maritime law and regulation gives the reduction on the legal risk and reduce the diversity among the system. Therefore, it is obvious that the harmonization is necessary in order to make the degree of international standard and uniformity ultimately.

In terms of VTS, no doubt harmonization is necessary as well. This is especially true when looking at the VTS guidelines of IMO (IMO, 1997) that reflect the maritime safety regulation as “Recognizing also that the use of differing vessel traffic service procedures may cause confusion to masters of vessels moving from one vessel traffic service area to another”. Besides the harmonization, however, figure 5 shows the linkage between international and national regulations in the VTS system.

![Figure 5: General legal framework of VTS](image-url)
2.4.1 International Legal Framework for VTS

The international legal framework provides the overall structures of public instruments for establishing the provisions and fulfilling the requirements of VTS internationally. The following frameworks are crucial for any VTS regime;

(a) United Nations Convention on the Law of the Sea (UNCLOS) and its relations to VTS

The UNCLOS was adopted in 1982 and came into effect in 1994. It formulates the inclusive direction of the law and order regarding to the global oceans and seas. For example, it sets up the rules that governs the usage of such oceans and resources in general. The coastal states’ sovereignty ranges beyond its internal water to the territorial sea. Hence, the exercise of sovereignty over the territorial sea is based on this UNCLOS as well as other rules of international law (IALA, 2016).

For the reason, the jurisdiction of member states can be claimed in different zones including internal waters, territorial seas, contiguous zones, archipelagic waters, exclusive economic zones (EEZs) and the continental shelf (Luttenberger & Luttenberger, 2014). As a result, when the VTS is considered, the establishment of jurisdiction to VTS area becomes important. This is why the geographic coverage of VTS operations is limited by the jurisdiction of the coastal state within the territorial waters and there is no mandatory outside such area (IALA, 2016).

According to Allen (2009), the UNCLOS imposes the coastal states’ duties in providing services to vessels, which is in a very limited way in exercising power. It is thereby affecting the establishment of VTS as a whole because of the power of states. Another researcher (Segar Abdullah, 2000) argues that there are no provisions that clearly state for setting VTS as an obligation. However, the authority may establish the VTS center to provide safety of navigation and marine environment protection by claiming the right to control the territorial waters and mandating the participation in
VTS scheme to monitor the movement of the vessels. Segar Abdullah (2000) also lists examples of measures that reflect such purposes including traffic separation scheme, and mandatory sea lanes.

In the straits being used for international navigation, as e.g. Straits of Bosporus or the Sound in the Baltic Sea and many others, the authority who is providing the VTS service, could not impose the innocent passage of the vessels under Article 43 of the UNCLOS. In this case, the authority should set the agreement jointly between bordering states or other maritime nations to agree the standards for monitoring the vessels navigating in the waters. These standards may include the requirement of ship reporting system or the provisions of the voluntary participation in a VTS.

(b) IMO Conventions and their instruments related to VTS

IMO has been mentioned in the Article 2 of Annex VIII of UNCLOS. The provisions refer to the IMO in adoption of international shipping rules and standards regarding to the maritime navigation safety and the marine pollution protection from the vessels.

Many conventions have been adopted by IMO and other organizations regarding to the maritime safety, marine pollution and liability as well as compensation. However, there are two main conventions that directly relate to VTS and in which it provides guidelines for the establishment, organization, and operation of VTS, as well as training and certification of VTS personnel. These can be included, namely, the International Convention on the Safety of Life at Sea (SOLAS) 1974, in Chapter V Regulation 12, and the Convention on Standards of Training, Certification and Watchkeeping of Seafarers (STCW).

SOLAS is an international convention imposing the safety of the ships. It was firstly adopted in 1914 because of the Titanic disaster. It was amended and adopted in the second version in 1929, the third in 1948 and the fourth in 1960 respectively. Furthermore, there was the 1978 Protocol with the tacit acceptance procedure which
provides the amendments and codes concerning the international standards of vessel construction, design equipment, and manning (CDEM) (Allen, 2009).

In the SOLAS, Chapter V identifies the navigational safety which should be given by the Contracting Governments and establish the regulation for all vessels and all voyages. However, IALA (2016) argues that this chapter is distinction compared to other chapters because others are all concerning to the class of ships – CDEM - engages to the international voyages.

For the VTS, it was mentioned in Chapter 5 Regulation 12, which came into force in July 2002. It states the guidelines for VTS as below;

“1. Vessel traffic services (VTS) contribute to safety of life at sea, safety and efficiency of navigation and protection of the marine environment, adjacent shore areas, work sites and offshore installations from possible adverse effects of maritime traffic.

2. Contracting Governments undertake to arrange for the establishment of VTS where, in their opinion, the volume of traffic or the degree of risk justifiers such services.

3. Contracting Governments planning and implementing VTS shall, wherever possible, follow the guidelines developed by the Organization. The use of VTS may only be made mandatory in sea area within the territorial seas of a coastal state.

4. Contracting Governments shall endeavor to secure the participation in, and compliance with, the provisions of vessel traffic services by ships entitled to fly their flag.

5. Nothing in this regulation or the guidelines adopted by the Organization shall prejudice the rights and duties of governments under international law or the legal regimes of straits used for international navigation and archipelagic sea lanes.”
In respect of STCW 1978, it became effective in 1984, setting out the international standards for seafarer qualifications and training, as well as setting the standards of deck and engineering watch-standing. It provides the necessary conditions on the ship owners or operators, the master of the ship as well as watch officers. Allen (2009) points outs STCW as: “STCW prescribes internal risk management measures that must be considered in any examination of existing or proposed external risk management measures, such as VTS”

In addition, it also includes the requirement of the learning prospective of deck officers regarding to the ship reporting system – VTS reporting procedure – and the Standard Marine Communication Phrases (SMCP) in which VTS operators are obliged to use to communicate with vessels.

Therefore, it is undeniable that the UNCLOS and IMO Conventions can be seen as umbrellas in implementing the VTS for monitoring maritime traffic, safety and the efficiency of navigation within the jurisdiction area.

(c) IALA to VTS

The International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) is a Non-Governmental Organization (NGO) founded in 1957. At present, there are approximately 75 national members and 30 affiliated organizations from all parts of the world (IALA, 2018). IALA gathers marine aids to navigation authorities, manufacturers, consultants and training institutes to exchange the experiences for VTS development.

IALA encourages its members to jointly work to create a harmonious interaction regarding aids to navigation around the world. This is because the purpose is to ensure that the movements of the vessels are safe and efficient while the environment is also protected. In this regard, IALA has urged the experts around the world to establish its
committee in order to produce the best practices through the publication, namely, IALA Recommendations and Guidelines.

In terms of VTS, IALA has worked to develop VTS for almost 50 years starting from the basic discussion of shore-based radar installation to the advance technology implementation of today. IALA recognized the development of VTS because there was still no coordination and differences among counties implementing the VTS system. Therefore, the VTS committee was created in 1980 to take this problem into account and play a key role in guiding VTS. Furthermore, IALA has worked closely with maritime consultative bodies as a part of the VTS committee. These include:

- The Nautical Institute (NI)
- International Association of Ports and Harbour (IAPH);
- International Federation of Shipmasters’ Association (IFSMAM);
- International Harbour Masters Association (IHMA);
- International Maritime Pilots’ Association (IMPA);

Since 1985, IALA has been involving in providing the guidelines concerning VTS. Although the Resolution A.857 (20) has remained similar, IALA still develops the information, as required, in the VTS manual which is updated in every 4 years (IALA, 2018). IMO has recognized the achievement of IALA in producing the recommendation and relevant documents and encourages member states to implement the VTS and to use these documents. Following this, IALA standards are known generally in the primary training and certification standards for VTS personnel. For instance, VTS Manual 2016, Chapter 12 VTS personnel and Chapter 13 VTS training and qualification, suggests how the VTS authority considers effectively and efficiently the roles and responsibility as well as technical support for VTS. According to IALA (2018), below are examples of the published developments;
recommendations on technologies and practices that are intended to improve the services being provided, such as Training of VTS personnel, the provision of AIS facilities by shore authorities, the implementation of DGNSS stations and the Photometry of Marine Aids to Navigation Signal Lights;
- model courses to supplement the Recommendations on the training of VTS personnel;
- guidelines that either supplement recommendations or provide advice and guidance on how new and developing technologies can be used to improve the operational or cost effectiveness of services.

2.4.2 National Legislative Measures for VTS

The contracting states who access or ratify the international conventions or protocol, such as UNCLOS, STCW and SOLAS, are obliged to enact the national legislation appropriately in order to reflect the provisions that have been agreed. Those enactments will be covered in provisions for enforcement and sanctions for infringements. The contracting government may select the way to undertake the responsibility to emerge the international agreements into the national legislation. Practically, most contracting governments will rely on the two boards. This includes Marine, Shipping, Merchant Shipping Laws or Acts which are concerned with the flag of the ship and Harbour, Port, Docks Laws or Acts concerning the geographical jurisdictions (IALA, 2016)

However, in general, the regulatory framework of VTS is not explicitly mandated by creating specific VTS provisions, but the contracting government, which is a part of SOLAS, is able to do so as it provides the right in implementing the VTS as appropriate. In this particular case, many countries attempt to put the provision in the harbor acts instead. The harbor acts are national levels and it is also a uniformity itself to all ports who are undertaking it. This is because the local legislation can be
implemented depending on the specific area. Therefore, it is clear that regulating under national legislation is important in implementing the VTS system.

Abdulla (2011) demonstrates that although there are no fixed manners in creating and exercising the VTS in national legislation from the previous literatures, the contracting states who already have their VTS regulations will have to oblige with the IMO and IALA recommendations and guidelines. Some of contracting governments are surpassed while others have their own regulations which do not commonly conform with international standards.

The legislation of contracting states is supposed to conform with the minimum standards appropriately as set out in the IMO guidelines and IALA recommendations for VTS. The act will be named depending on the purpose itself whether it is separated explicitly or if it will be accumulated with other acts. For example, Australia has implemented the obligation under SOLAS in the Navigation Act 2012 and Marine Order 64, which VTS established. Table 1 demonstrates the example of countries successfully passing acts regarding VTS (IALA, 2016):
<table>
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<tr>
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<tbody>
<tr>
<td>Australia</td>
<td>Navigation Act 1912</td>
<td>Marine Orders 64 (VTS 2013)</td>
<td>Marine Notice 8/2014 (Australian Vessel Traffic Services), VTS Compliance and Enforcement Policy</td>
<td>N/A</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>The Shipping and Port Control Ordinance, Chapter 313 of the Laws of Hong Kong SAR.</td>
<td>Sub-legislation: The shipping and Port Control Regulations (Chapter 313A of the Laws of Hong Kong SAR)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>Scheepvaartkeerwet (Shipping Traffic Act 1988)</td>
<td>Various Statute Orders and ministerial Decrees</td>
<td>None</td>
<td>Port or local area bye-laws established by the local competent authority</td>
</tr>
</tbody>
</table>

Table 1: Example of national legislation, statutory instruments and regulatory guidance for VTS (IALA, 2016)
2.5 IMO Guidelines for VTS

In principal, the main purpose of VTS is to improve the safety of navigation in responsible areas or areas where volume of traffic is high, as well as the location where the freedom of movement of shipping is restricted by any uncertain conditions such as restricted sea room, limited depth, dangerous area, unreliable weather condition and visibility, existence of obstruction to navigation. In line with this, IMO recognizes the important of implementing the VTS and provides the recommending measures concerning such systems in the international level.

In 1985, IMO adopted Resolution A.578(14) – Guidelines for Vessel Traffic Services. It defines the vessel traffic services, describes the role and powers of VTS authorities, forms the three main functions of VTS, suggests the procedures for implementing VTS operations, and recommends criteria for VTS in the location that has not been implemented yet. However, the improvement of such guidelines has been discussed continuously over the past decades because of the experiences gained where it has been revised by the Sub-Committee on Safety of Navigation together with the basis of revision provided by IALA, in co-operation with other relevant international organizations.

In 1997, IMO adopted Resolution A.857(20) – Guidelines for Vessel Traffic Services. It is a major revision of previous guidelines for VTS in its Annexes 1 and 2. It provides further criteria for VTS in terms of the recruitment, qualification and training of VTS operators.

Member states are encouraged to assure that the VTS which is being implemented in their territorial waters are managed in a manner of conformity with national law and international law. Such members are also urged not to obstruct the right of innocent passage through the waters and assure that the vessels navigating outside the territorial waters are able to use the service provided on a voluntary basis. With this regard,
it was recommended by IMO to urge the vessels navigating in the VTS responsible area to use the services of VTS as appropriate.

Despite the fact that there is no provision in the guidelines that clearly interprets as prejudicing the rights of vessels in navigation, the states which are implementing the VTS are suggested to follow the guidelines, as appropriate, to interact among interests harmoniously in order to improve the maritime safety efficiently and effectively.

Therefore, it is clear that the guidelines are providing the guidance for designing, planning and operating the VTS as well as describing its functions. Besides, the guidelines also mean to support the international harmonization by considering the current practices of VTS. All of these will be based on the relevant recommendations and resolutions adopted by IMO.

Moreover, the member states are urged to assure that the VTS authority provides adequate staff with well qualified, appropriately trained, and being able to perform the assigned tasks competently. These are all suggested by the IMO guidelines in the recruitment, qualifications and training of VTS operators. Furthermore, the study of Hafez (1998) suggests that the VTS should also organize the suitable standard for shore and off-shore based equipment.

It is also to be mentioned that there is ongoing activity to revise the existing IMO guidelines in order to address the needs for effective operation of VTS in the light of latest technological developments as well as to clarify and to overcome confusions that have been identified by the authorities and users of VTS. The revision of VTS resolution will be 8 key areas including role of competent authority, changing traditional boundaries, VTS and future development, types of services, result-oriented instructions, VTS qualifications, training and certification, recognition of IALA standard relating to VTS and administrative amendments (AMSA, 2018: IMO, 2018b:
Patraiko FNI, 2018). However, this dissertation will strictly follow the existing and presently valid rules and regulations established by IMO and IALA

2.5.1 Legal Consideration for VTS

When the competent authority makes a decision to establish the VTS system within its port or water way in order to provide the safe navigation through VTS services, it shall determine the regulations or rules according to the operation of VTS system together with its responsibility and liability in accordance with IMO resolutions (IALA, 2016). Additionally, the authority has to form the training requirements of VTS operators in order to ensure that the operators are able to work precisely.

(a) Authority

According to Mohamed (1997) and Hafez (1998), A statutory authority should implement the VTS service in order to improve the safety of navigation and protection of the marine environment for the vessels in the responsible area – jurisdiction area by exercising the powers. These powers are ordinarily exercised by the enacted law of the central government or any other organization, which has a direct responsibility for VTS in the country.

In general, the national law and regulations are enacted to establish the surveillance system in order to monitor and control the vessels, thereby creating the safety and efficiency of navigation as well as protection of the marine environment. These laws provide not only the power to authority to implement and operate the VTS, but also enforce to all vessels for compiling with the VTS rules. For example, enforcing to equip the standard equipment, using the specific communication procedure. Because of the provided power, the VTS authority can perform more control over the vessel traffic specifically in hazardous areas, unsafe circumstances, congestion areas, poor visibility, and adverse weather.
However, there is an argument (IALA, 2016) that the enacted law should clearly describe the degree of exercise of VTS authority in controlling the vessel traffic. This could include following considerations (Mohamed, 1997):

- Specify times of entry movement or departure
- Establish vessel size, speed and draft limitations and vessel operating conditions
- Restrict operations to vessels having particular operating characteristics and capabilities, and
- Instruct vessels to act when justified in the interest of safety

In the meanwhile, the legislations, which are providing the power to VTS, should consider the fact that shipping is characterized as an international activity. Therefore, the innocent passage and freedom of navigation under UNCLOS is a crucial part for this matter (Kuma, 2015). Those laws should be in line with international conventions eventually.

(b) Liability
Despite the fact that VTS authority recruits well-qualified personnel for operating the VTS system, there should be consideration for the further responsibility of the action of those personnel. This is because if the accident occurs, the question arises who will be liable in such a case? According to Corbet (1989) and IALA (2016), this question is occurring continuously over a period of time. It is a very complicated question on the legal consideration among key players including masters, pilots, shipowners, and VTS, where it is decided upon case by case (Hafez, 1998)

In the circumstance VTS operators instruct the vessel and unfortunately an accident happens because of its duties’ failure. The liability of maritime law would then be generally applied depending on specific circumstances. MacWilliam & Cooke (2006) argue that although the liability of VTS is recommended on the IMO resolution that the VTS authority should consider carefully the legal implication of the VTS. Such a
question still exists if the accident occurs from the VTS’s personnel’ failure. However, they also point out that there is no report and research indicating the clear judgement anywhere in the world which previously deal with the liability and obligations of the VTS.

2.5.2 Operational Rules and Procedure

According to IMO Resolution A.857(20), there are two operating procedures including internal and external procedures. Internal procedures are concerning the operating tools and functions between personnel and internal routing and distribution of the data. In contrast, external procedures are dealing with the relationship of users and allied services as clearly indicated in VTS functions above.

The operation procedures should be explicitly defined to address the operational procedure and relevant duties of personnel. Such procedure should form the actions to be taken in the matter of interactions with vessels and other related parties as well as emergency situations both externally and internally in order to manage the responsibility effectively (IALA, 2016).

2.6 VTS Personnel, Training and Qualification

The demand of human elements to operate the VTS are increasing continuously over a period of time due to the increasing of technology, complexity of legal matters, communication development, increasing of traffic density and of course increasing of VTS center around the world (Eriksen, Hoye, Narheim, & Meland, 2006: IALA, 2016). From these perspectives, it is undeniable that human elements in VTS, which is VTS operator, is a crucial component of VTS system (Kuma, 2015).
According to Segar Abdullah (2000), VTS operators are playing significant roles in attaining the prospective objectives of any VTS in the world. Such roles have emerged and developed over the centuries, where it varies remarkably from one system to another. The characteristics and requirement of VTS operator’s duties are based on the type of services, operation, scope, age and advancement of equipment using in VTS system. In some VTS center, VTS operators provide only simple information to vessels, while some other VTS center, VTS operator perform more complicated task as a traffic manager. Moreover, some VTS centers, which are installed state-of-art VTS systems, support VTS operators to get more involved by providing the instructions in the navigation of vessels at sea.

Because of the variation in the tasks of VTS operators, most of them are performing the duties with unclear guidance. As a result, there is no standing place for them in many cases. Another different view is the varying backgrounds of VTS operators. For example, some VTS operators are usually trained, while others find their own approach through only on-the-job training. These standards are not recognized and qualified internationally. Therefore, it is undeniable that the standardization of qualification for VTS operator should be set out internationally and nationally.

IMO recognized the importance of setting the standard of VTS operator. It adopted the IMO Resolution A.857 (20) to provide the guideline on the recruitment, qualifications and training of VTS operator. The main purpose is to ensure that the VTS operator is well qualified with skills, background, qualification and training.

These guidelines have led IALA VTS committee to work closely with IMO to develop the comprehensive documents on standards for training and certification of VTS personnel. With high contribution of member of VTS committee, IALA has developed additional model courses for guidance on the recruitment of VTS personnel, training and certification and a model for operational job descriptions (Segar Abdullah, 2000).
These recommendations are well organized and structured, which covers all aspect of VTS personnel, categorizing as operators, supervisors, managers or instructors. There is also recommendation for proper selection and recruitment including aptitude and medical tests (IALA, 2016). Additionally, the requirements ensure that the professional competency is maintained such as annual assessment, revalidation requirements.

IALA (2016) has published a number of guidelines and recommendations in respect of VTS personnel including;

- Recommendation V-103 on Standard for Training and Certification of VTS Personnel
- Model Course V-103/1 – VTS Operator Basic Training
- Model Course V-103/2 – VTS Supervisor Advancement Training
- Model Course V-103/3 – VTS On-the-Job Training
- Model Course V-103/4 – VTS On the Job Training Instructor
- Guidelines for the Accreditation of VTS Training Institutes
- Guidelines on the assessment of training requirements for existing VTS Personnel, Candidate VTS Operators and the re-validation of VTS Operator Certificates
- Guidelines on designing and implementing simulation in VTS training at Training Institutes and VTS Centers
- Guidelines on the aspects of the training of VTS Personnel relevant to the introduction of AIS
2.7 Thailand VTS

VTS systems have been recognized in Thailand primarily when the first VTS center was established. It was called Sriracha VTS under the authorization of Vessel Traffic Control and Maritime Security Office (VTCMSO). Dated back to the history, the government of Thailand has focused on the ongoing improvement of the national maritime policy especially maritime safety and efficiency.

At first, in 1999, the cabinet mandated the Marine Department of Thailand to carry out the vessel traffic management and security control in order to ensure the safety and efficiency of navigation, increasing environment protection, managing port as well as cargo operation due in Sriracha Bay and Si Chang Island in the upper Gulf of Thailand (GoT).

While the relevant arrangements were prepared by the Marine Department of Thailand, IMO has amended the International Convention for the Safety of Life at Sea (SOLAS) 1974 in 2002 together with the International Ship and Port Facility Security Code (ISPS Code) and entered them into force. As a result, these impose on the vessels which are equipped with the Automatic Identification System (AIS) as a means to informing the vessel’s identity to all relevant parties, including nearby vessels, and AIS based stations. This aims to enhance operational safety and waterway security after international terrorism and piracy having been major international issues.

For that reason, Thailand, as a member of IMO, has reflected on the IMO recommendations swiftly through its Marine Department of Thailand by establishing the Vessel Traffic Control and Maritime Security Office (VTCMSO), under the cabinet’s resolution in July 2005, at Laemchabang port in the eastern part of Thailand. The responsibilities are as follows;
- control, monitor, and facilitate marine transportation in the entire area of responsibility in the territorial water of the kingdom of Thailand and traffic service at every port throughout the country
- coordinate with certain agencies that are responsible for the national security and safety of ships at sea and ports in order to set directives on the safety aspects
- coordinate with certain agencies that handle the security service in case of any treat to ships and ports
- set the threat levels and security measures to be provided to ships and ports in accordance with the crisis as well as announce any change of threat level to Thai flag ships, ports, and in-bound foreign ships in the territorial water of Thailand or at the ports
- perform as the coordination center for the safety protection and security service for ships and ports. Upon receiving any alert on the threat to ships or ports. The main center will coordinate with related agencies to duly carry out rescue in line with International Ship and Port Facility Code (ISPS Code)

To fulfill the above mission efficiently, the Marine Department of Thailand authorized the Vessel Traffic Control and Maritime Security Office (VTCMSO) to establish a VTS system phase 1st to serve at the upper gulf of Thailand, called Sriracha VTS. Therefore, Sriracha VTS under VTCMSO is responsible for the management of the VTS system in Thailand. Its major task is not only providing a service, but also policy-making for the VTS system, administration, and co-operation with other organization.
2.8 Summary

This chapter provides the insight development of VTS and its contributions. Generally, VTS is a term defined principally and adopted by IMO. By its definition, VTS is a service aiming to improve the safety and efficiency of vessel traffic, safety of life at sea, as well as enhancing the protection of the marine environment. Over the centuries, VTS has been continuously developed, ranging from simple aids to navigations to high sophisticated systems. This service provides different functions and types of services depending on the decision of the competent authority, where a number of criteria are based on. This is because VTS is being regulated on different levels of laws and regulations including UNCLOS, SOLAS, international guidelines and other national laws. Therefore, member governments are encouraged to ensure that the VTS within their territorial sea are operated in accordance with national laws and applicable international laws. In parallel, it is recommended to follow the international guidelines as appropriate in order to fulfil the interest of international harmonization.
CHAPTER 3
RESEARCH METHODOLOGY

The literature review on the VTS in Chapter 2 comprehensively explains the insight of VTS development and its contributions. These include VTS development, definitions, functions and services, legal framework, IMO guidelines particularly the guidelines on recruitment, qualification and training of VTS operators, and where present, the underlying principles of the research approach for this dissertation. These principles produce the appearance of research in both depth and breath, while also drawing the design of the research.

Figure 6: Research methodology summary (Adapted from Ambituuni, 2016)
Essentially, this chapter presents the methodology used in the research. Figure 6 shows the summary of inclusive methodology developed into four different layers. Those layers provide the strategy in the research process including research methodology, successful case studies, qualitative method, and data collection and analysis.

This research is organized into eight main sections. The first section presents the nature and design of the research. The second to fifth section consider the data collection in the context of studying comprising of the primary and secondary data, while the data collection process is also presented. The sixth section provides the details of ethical considerations during the data collection process. Finally, the seventh section deals with the data analysis in terms of how the collected primary data will be utilized and integrated with the secondary data in order to provide meaningful conclusions. The summary of chapter 3 is presented last.

3.1 Nature of Research

This research is qualitative in its nature. With its research problem, the research questions are raised with What? and How? in a specific topic, where the answer should be sought in order to figure out the better solution. These WH-questions are concerned with the qualitative inquiry, which aims to understand the particular situation in the research (Creswell, 2007). According to the qualitative approach, Abdulla (2011) states that “Qualitative is not on numbers but on words and observations, stories, visual portrayals, meaningful characterization, interpretations and other expensive descriptions.” On the other hand, the quantitative method is dealing with Why? which aims to find the correlation of the numbers and variables in the language of statistics and mathematics (Kaplan, 2004). In terms of this research, it is focusing on Thailand VTS by understanding the roles and identifying the critical problem in Thailand rather than focusing in measurement and observation of quantitative data, where the research question is in more specific different approach. Therefore, this research is determined as a qualitative approach which is characterized in exploratory research. This is
because the major focus of this research is to explore the gaps or critical problems of Thailand VTS in the current real situation (Stebbins, 2001).

3.2 Research Design

The overall research is carried out in a sequential manner. The research questions are answered by conducting the following approaches. Firstly, the literature on the development and principle of VTS, framework of international guidelines and manual as well as case studies of other successful countries together with Thailand’s are reviewed. Secondly, the critical limitation and ongoing situation of Thailand VTS are explored by collecting data from related documentations and Thai and international experts, who are highly experienced in this particular context, using the in-depth interview as a tool. Thirdly, the data will be processed using descriptive and content analysis in order to provide the initial findings and critical limitation of Thailand VTS. These are discussed along with the secondary data consolidated from published documents, journals. Ultimately, recommendations are derived and developed as suggestions for the related parties to use in the future.

3.3 The Triangulation of Data

The design of data collection in this research comprises three different research methods. This is because, theoretically, the data can be improved to be of greater precision by considering multiple viewpoints collecting in different kinds of data on the same phenomenon (Jick, 1979). Decrop (1999) suggests that qualitative research can be strengthened by combining various sources of data, which are not interrupt or oppose themselves. Flick (2004) also explains that playing in different process methods can maximize the data’s validity. These three different methods are leading to the triangulation of data which enables to an exploratory and analysis of critical limitation of VTS in Thailand.
According to Kulsiri (2006, p.150 as cited in Hittleman and Simon, 2002, p.183), it is defined that “triangulation is a procedure for cross-validating information. It is a process of collecting information from several sources about the same event or behavior” Therefore, triangulation of data involved in a complex process combining the data from different sources, different times and different places or people. These are the processes approaching the data with multiple perspectives.

![Figure 7: Triangulation of Data](image)

The triangulation of data in this research comprises of (1) gathering all the relevant documentations related to the VTS in Thailand and its general principles; (2) conducting interviews with Thai VTS operators; and (3) conducting interview with management levels of VTS center and relevant organization in Thailand. Nevertheless, all these parts are not great important in the same extent. This is because the main purpose is to explore the gaps. Thereby, the most significant part is the interview of VTS operators in Thailand, while the second most significant is the documentation related to VTS in Thailand and its general principles. In addition, the interview of management levels of VTS center in Thailand will be a supportive information in order
to produce better analysis. Figure 7 illustrates the linkage of different sources of data, which are used in one analysis.

3.4 Gathering the Documentation of VTS operation

Gathering the documentation is one of the methods that enables researcher to explore the gaps remaining or identify the critical limitation of VTS in Thailand. The documentations provide crucial information in accordance with VTS’s history, establishment, procedures and relevant activities in Thailand. These are leading to the critical analysis significantly, while shaping the basis of the research also.

The documents comprise of various kinds of Thai government legislation and policies, VTS procedures and announcements, training materials, supporting documents, VTS job descriptions, organizational charts, and other relevant documents.

Moreover, the international resolutions, guidelines, and manuals provided by international organizations, who have a key role in improving and guiding the VTS together with the case studies from successful countries are utilized for the process of analysis. These includes the documentations from IMO, IALA, WMU and VTS centers e.g. IMO resolution and guidelines, IALA VTS manuals, WMU’s dissertations, and procedures of VTS centers.

3.4.1 Official Documents of Thailand VTS

In order to achieve the research’s objective and the gathering of the documentation procedure, the researchers selected the lists of official documents of Thailand VTS below for analysis. This is because they are the main focus of the research and they provide the comprehensive views of the current situation related to the status of VTS implementation and development. The lists are as follows;
(a) Announcement of Marine Department, No.229/2557 on the recruitment of officers
(b) Announcement of Marine Department, No.102/2560, Vessel Traffic Control and Maritime Security Office – VHF radio reporting system
(c) Navigation in the Thai Waters Act B.E.2456
(d) Term of Reference for Vessel Traffic Management and Information System
(e) Vessel Traffic Control and Maritime Security Office – Reporting system procedure
(f) Training Curriculum of VTS Operators

3.4.2 Document Collection Procedures

The documents were started and collected during the beginning of second semester of the master’s program. The researcher collected all relevant documents concerning VTS in detail from available public sources on the Marine Department’s and Vessel Traffic Control and Maritime Security Office’s web pages from the internet. Some of them were found and collected from the internet such as official websites and social media, while others were requested to be sent to the researcher from the Thai officials on their data bases.

3.5 Interviews

The interview is the main source of data collection in this research. It provides the focus on the exploring the critical limitation, which requires the analysis of practical process thereafter. Only gathered documentations cannot be covered the main focus of research comprehensively without the practical data and information obtained from experienced persons, for instance by interviewing experienced persons in real situations who are working directly as a part of operation and development in VTS authority and VTS center of Thailand. These includes active and non-active VTS operators and supervisors, senior officials, and directors. Therefore, in order to collect
the necessary data for an analysis, the interview method was selected as a tool for acquiring informative data (Opdenakker, 2006).

### 3.5.1 Procedure for Interviews

Interviews were held during May 2018 to July 2018. At the beginning, the initial contacts were made by email, telephone and social media platform to confirm the request of an interview. After getting the confirmation, the schedules were drawn up based on the availability of interviewees individually. The interviews were conducted on online basis using an international call because of distance limitation. The interviewer was in Sweden, while all interviewees were in Thailand. Interviews were carried out in the Thai language, which was translated into English thereafter.

### 3.5.2 Participants

The selection of participants is a very important part of a research as it is contributing to the greater understanding of a data and theoretical principles at last. In this research, 10 interviewees were chosen from two groups including VTS operators working in Thailand and management level team based on the purposive sampling technique. According to Etikan, Musa & Alkassim (2016), the purposive sampling technique is a technique in selecting the participant with non-random technique. It allows the researcher to decide the needed participants because there are no underlying theories or a specific number of sampling. Some of the criteria were set in order to ensure the quality of data, for example by experience of being a VTS operator in Thailand, knowledge related to the topics, willingness and accessibility. However, in order to look at all available angles as a broad spectrum, the Maximum Variation sampling method was also used to collect the data.
3.5.3 Interviewing Methods

Interviews were carried out individually on an online basis by the researcher because of the distance limitation. The telephone and social media platforms, that allow the researcher to make an international call, were used to conduct the interview effectively. In order to understand the experience’s interviewees, the in-depth interview method using semi-structure is the most appropriate approach. This is because it unfolds in a conversational manner offering the interviewees the chance to explore further ideas except answering the particular questions (Longhurst, 2003). It also offers insight data which enables researcher to explore the critical limitation of VTS in Thailand (Galletta, 2013).

In addition, in this research, the schedules, questions, time and available place (online) were already prepared in the interview process precisely. Therefore, it ensured that the standard of interview was in line with the theoretical method, topics and atmosphere. As a result, there was no deviation of the data collection during the interviewing process (Galletta, 2013).

3.5.4 Interview Questions

Interview questions were designed based on the open-ended questions. Open-ended questions are the approach, which allows the interviewees to answer the questions without the influences of researcher. Some of the researchers (Reja, Manfreda, Hlebec & Vehovar, 2003) identify the advantages of open-ended questions including increasing the possibility of discovering and avoiding the bias of researcher. Moreover, the interviewees could possibly respond within unexpected suggestion while in the interviewing process. Simultaneously, the interview questions were ensured the reliability and validity by comparing with the model questions from various sources such as the thesis and international guidelines (e.g. IALA Guidelines 115 Preparing for an IMO Member State Audit Scheme (IMSAS) on VTS, and 1101
Auditing and Assessing VTS). Subsequently, the interview questions were tested and rehearsed during a pilot episode with academics, experienced professionals at WMU. The list of interview questions can be found at Appendix 1.

3.6 Ethical Consideration

In conjunction with the WMU’s ethical procedure, the interviewees were provided briefly research information including topic, purpose and objectives of the study in order to ensure that all interviewees understand the process and rationale of the research. The interviewees were then informed clearly that such interview is on voluntary basis and anonymous, where they are allowed to withdraw from interview at any time.

Additionally, all collected data and personal data of interviewees were kept in a secure manner confidentially throughout the period of study. After the research has been completed, they will be destroyed. All personal data without obtaining the consent form, was not used be according to the procedure. The consent form can be found at Appendix 2.

3.7 Data Analysis

The data analysis process commenced after the data collection process. The first interviewee was given the conclusive information regarding to the process of the data analysis, while the following interviewees were reshaped in the data collection process to be suitable to the purpose of the study. This is because Frechtling & Sharp (1997) suggested that the data during the collection process can be interpreted along with the data collection. As a result, the research questions could be revisited for strengthening the research’s objectives. Subsequently, the documentations were reviewed in order to see the reliability of the data. Those documents were mainly listed
in 3.4.1 the Official Documents of Thailand VTS, which were written down from Thai to English by the researcher.

The full analysis of the collected data – documents and interviews – began by using the framework of VTS international guidelines and manuals described in Chapter 2 and research methodology in this Chapter 3. They were examined and interpreted to describe the main focus of research in sequential manner. Despite the fact that there is no specific method to analyze the collected data in qualitative methods, some of approaches can be addressed in order to get the meaningful result (Frechtling & Sharp (1997), Abdulla, 2003 as cited Saunders, et al (2000))

According to Frechtling & Sharp (1997), qualitative modes of data analysis give the approach in discerning, examining, comparing and contrasting, as well as interpreting meaningful themes and patterns. Those themes and patterns are established by the specific goals and objectives of the research. At this stage, the same data can be analyzed and synthesized from different views. A number of approaches qualitatively including content analysis, narrative analysis, discourse analysis and textual analysis can be utilized to produce the valuable and functional result.

Therefore, in this research, the researcher undertook the organizing of data, identifying patterns, and synthesizing major ideas (Whittemore & Knafl, 2005). The collected data from both the documentations and interviews of the VTS operators were organizing and categorizing. The organized and categorized data were described into patterns and themes representing the coding categories against the qualitative method. The broad spectrum of interviewees’ point represents the variety of theme and patterns categories. These allowed the researcher to explore the critical limitations of VTS in Thailand. Later, researcher emerged the findings together with relevant literatures to compare and contrast with relevant VTS international guidelines and recommendations, reflecting the research questions on the gap identification. These analytical procedures were based on several modes and characteristics of qualitative methods and were
3.8 Summary

This chapter provides the research methodology used in the process of data collection. It is a qualitative method in its nature as it intends to explore the critical limitations of Thailand VTS. There are several sources of data used in this research including documentation, and interviews from different groups in same scenario, which provide the reliability and validity of the data as called triangulation of data.

The first data collection comprises of the relevant VTS literatures including various kinds of Thai government legislation and policies, VTS procedures and announcements, training materials, supporting documents, VTS job descriptions, organizational charts, and other relevant documents. These documents were obtained from several approaches, where they are publicly available, others or provided by informants.

The second collection is the interview from two different groups of VTS personnel in Thailand including VTS operators and management level team. Without these factual opinions from these people directly, the researcher would not have been able to understand the current situations and identify the gaps remaining in Thailand VTS. The interviews were conducted on online basis because of the distance limitation, while the interview is semi-structure with open-ended questions. These interviewees were anonymous, where the ethical issues were considered carefully for their confidentiality. Overall, this chapter presents the analysis procedure of the collected data using the VTS framework described in Chapter 2.
CHAPTER 4
DATA ANALYSIS AND RESEARCH FINDINGS

Chapter 3 presented the research methodology and theoretical framework which are underlying principles of the research approach and investigation. It provided the principles specifically applied in the designing of the research and why both the documentation and interviews of VTS’s organization in Thailand were used as a research tool.

In this chapter, the research findings are presented in connection with the research objectives. The roles of Thailand VTS in terms of its capability to enhance the safety and efficiency of navigation and the current ongoing situations are addressed by reviewing the documentations, while the critical limitations are explored by conducting interviews. These findings are presented in a sequential manner and they are established into themes and patterns based on the data analysis described in chapter 3 correspondingly.

Based on the research questions, this chapter is organized into 3 sections. The first section presents the roles of Thailand VTS and its current issues. The second section highlights the critical limitation of Thailand VTS in VTS implementation, while some other findings are also presented in the third section. The summary of important findings, which directly affect the development of VTS implementation and development in Thailand, will be described in the last section.
4.1 An analysis of the roles of Thailand VTS in terms of its capabilities to enhance the safety and efficiency of navigation and current ongoing situations

The study of Thailand VTS has been commenced by reviewing its roles for enhancing safety and efficiency of vessel traffic within responsible area of Thailand VTS. Such roles have been perceived by gathering and analyzing the documentation, listed in chapter 3, to gain insight of how VTS contributes to fulfill the organizational objectives in relation to VTS’s principles. In this research, Sriracha VTS has been studied specifically as it is the scope and is considered as a Thailand VTS. It is a VTS phase 1st as described briefly in chapter 2.

Over the findings, it can be seen the general view obtained by the documents that Marine Department of Thailand has duties and missions to control, regulate, facilitate marine transportation in order to ensure the safety of navigation, environment protection and law enforcement in the Gulf of Thailand. These have been highlighted in a number of documents especially the terms of reference for vessel traffic management and information system announced by Marine Department of Thailand.

Obviously, the safety of navigation in the Gulf of Thailand (GoT) is of great importance due to the increase in international and national maritime transportation. The Thai Government has realized the complexity of the maritime traffic and difficulties of navigation in Gulf of Thailand (GoT). As a result, therefore, the surveillance system, which is called VTS phase 1st and Sriracha VTS thereafter, has been established to cover the eastern part of coastal area including Ko Chaung, Ko Phai, Ko Lan and Ko Si Chang, Bangkok pilot station and the other main ports of Thailand. There are physical site data located in a number of places including Samutaketr Control Tower, Ko Si Chang, Kao Krom Luang, Ko Lan, Bangkok Pilot Station respectively.

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The surveillance system is responsible for the movement of vessels navigating in and out of Thai waters within 12 miles. The vessels are monitored in specific area up until the vessels proceed safely to the port area in order to ensure the safety of navigation and avoid uncertainties and dangerous situations potentially such as grounding, crossing points, collision, hazardous cargo, and dragging. Those situations are mainly managed by using the communications between shores and ships through the VTS components. For example, by broadcasting and announcing the marine traffic information to provide the traffic information, navigational assistance, and also search and rescue (SAR) mission. These operations provided from Sriracha VTS are 24 hours and 7 days a week (24/7).

Figure 8: The summary of Thailand VTS’s roles
The finding show that there are a number of roles supporting the activities of Sriracha VTS to enhance and improve the safety and efficiency of navigation through the traffic managements. Figure 8 represents the comprehensive views that Sriracha VTS gets involved in such activities. These include monitoring the traffic through the total surveillance system, increasing the awareness of incoming and outgoing vessels through maritime traffic, facilitation of the coordination among allied services and maritime parties, prevention of possible environmental pollution, collecting and recording the real-time traffic information. The current situation of each role can be elaborated as followings;

4.1.1 Monitoring the maritime traffic through the total surveillance system

According to the Announcement of Marine Department, No.102/2560, Vessel Traffic Control and Maritime Security Office – VHF radio reporting system and Vessel Traffic Control and Maritime Security Office – Reporting System Procedure, it can be clearly seen that Sriracha VTS has implemented the traffic routing, ship reporting to operate and monitor vessels for 24 hours-basis. Within Thai waters, especially the inner Gulf of Thailand (GoT), Sriracha VTS has a vessel traffic service, which is the marine monitoring system. It is used to keep track the vessels’ movements and provide through the ranges of traffic services, a limited geographical area as shown in figure 9.

In reference to the terms of reference of Vessel Traffic Management and Information System, the surveillance system is a system that provides the position of vessels within a particular area, which is used by VTS operators to monitor and control vessels. It comprises the Automatic Identification Systems (AIS), Radar, Global Positioning Service (GPS), General Packet Radio Service (GPRS), Global Navigation Satellite Systems (GNSS), Radio Direction Finder (RDF) and Closed Circuit Television (CCTV). These systems are designed for VTS operators to accommodate the current
positions of vessels in order to provide the useful navigational information, monitor the maritime safety, as well as to forecast weather information as it affects navigation.

With regard to the Navigation in the Thai Waters Act B.E.2456, there is a provision that authorizes the offices to control the maritime traffic through any of surveillance systems. This is clearly stated in the section 17-23 where vessels proceeding into Thai waters are strictly required to inform the Marine Department within 24 hours. Furthermore, it is required to use of the Automatic Identification System (AIS) when vessels are in the controlled area. Sriracha VTS has established the ship reporting system in order to ensure that the incoming and outgoing vessels comply with the legislation as shown in figure 10.

![Diagram](image_url)

Figure 9: Sriracha VTS operational area (VTCMSO, 2012)
Despite the fact that Sriracha VTS has an established VTS in accordance with VTS’s objectives provided by IMO resolution A.857(20), there are still a number of issues, when comparing with the IMO resolution A.857 (20), in operating a VTS. It is explicitly seen that there is no specific legislation authorizing VTS operators in Thailand to perform the duties. As a result, the liability of VTS operators has not yet been established. Furthermore, there are a few of the documentations stating the standard operating procedure for routine and emergency situations.

Figure 10: Sriracha VTS Ship Reporting System, (VTCMSO, 2012)
4.1.2 Increasing the awareness of incoming and outgoing vessels through maritime traffic

According to the Announcement of the Marine Department, No.229/2557 on the recruitment of officials, the duties of VTS operators have been defined. The duties of VTS operators are mainly in accordance with the VTS services and functions, specifically INS, TOS and NAS. This will increase the awareness of the vessels through ranges of services. The vessels will be monitored and controlled to navigate within the Traffic Separation Scheme (TSS) and VTS operational area, while navigational information is providing in case of dangerous situation including safety navigational information, grounding situation, crossing situation and weather information. Moreover, VTS operators are required to provide the advice information in case of emergency on board and navigational services as requested.

By referring to the Announcement of Marine Department, No.102/2560, Vessel Traffic Control and Maritime Security Office – VHF radio reporting system, Vessel Control and Maritime Security Office – Reporting system procedure and the Term of Reference for Vessel Traffic Management and Information System, it can be clearly seen that there is description stating the requirement of vessels to report to Sriracha VTS by using VHF.

This procedure requires the informative information in order to monitor, as well as making a decision for providing VTS services precisely. The information includes the name of the vessel and call sign, maximum draft, last port of call, port of destination, estimated time of arrival (ETA), next port of call, cargo class, number of crew and passengers, security level, defects and limitation, and the name of the ship agent. These data will be used by VTS operators to identify and monitor the incoming and outgoing vessels, meaning that it provides the awareness to vessels in terms of safety and the efficiency of navigation.
It is undeniable that Sriracha VTS keeps continuity of communication with vessels at all time (24/7) in order to increase the awareness of safety of navigation through ranges of VTS services. By comparing with IMO resolution A.857(20) and the Guidelines and Criteria for Ship Reporting Systems, and IMO Standard Marine Communication Phrases, it can be observed that the guidelines provide the recommendation that in operating the VTS, VTS authority should provide the full details of the requirements to be met and procedure to be followed in the VTS area. This information should be published in the appropriate nautical publications.

In addition, it can be ensured that the communication is conducted on the assigned frequency in accordance with ITU and SOLAS chapter IV. However, in Sriracha VTS, the information is not widely available and published in appropriate nautical publication especially the VTS requirement and procedures.

4.1.3 Facilitation of the coordination among allied services and maritime parties

In reference to the Announcement of Marine Department, No.229/2557 on the recruitment of officials, the coordination among allied services and maritime parties has been mentioned in the VTS operators’ duties. In terms of coordination, the VTS operator is required to coordinate within VTS’s organization in order to achieve the task’s objective efficiently and effectively. Moreover, it is explicitly required to coordinate with external parties in order to construct the relationship and co-operation among maritime parties. The main purpose of this cooperation is to provide the services and ensure that the maritime traffic within the area is safe and flow orderly.

According to the Term of reference for Vessel Traffic Management and Information System, the mission of Vessel Traffic Control and Maritime Security Office has been mentioned in order to provide the rationale of responsibility. The office has established, while the VTS center is serving its purpose. The office has to perform as
the coordination center for the safety protection and security service for ships and ports as well as related agencies to carry out the safety of navigation including search and rescue. Figure 11 demonstrates the allied services and maritime parties which Sriracha VTS gets involved in while co-operating.

By comparing with international guidelines and IALA manuals, it can be explicitly seen that the coordination between parties including internal and external as described in chapter 2 have to be made a clear and distinct procedure. The resolution also states that there should be the procedure to govern the daily routine as an integral part of the VTS operations. However, there is no clear procedure available for Sriracha VTS in implementing the VTS routine operation as well as the guideline on the cooperation with other allied parties, at least not at the moment.

Figure 11: Coordination among allied services and maritime parities, VTCMSO (2012)
4.1.4  Prevention of possible environmental pollution

When considering the VTS, there are a number of benefits of implementing a VTS. This includes not only the identification and monitoring of the vessels, but also the assistance of prevention and co-ordination of pollution response. These are clearly stated in the objectives of VTS in IMO resolution A.857(20) and IALA manuals.

In the view of Sriracha VTS, there are few provisions indicating the regulation on the prevention of environment pollution including regulations for ships and other vessels carrying dangerous goods, section 191 – 193, regulations on petroleum carried in cargo tank, section 199 – 208, regulations on anchoring near or dredging the anchor across cables, section 209 – 211 in the Navigation in the Thai Waters Act B.E.2456.

With reference to the Announcement of Marine Department, No.229/2557 on the recruitment of officials, this is a duty of VTS operators, which is relevant to the prevention of environmental pollution, as stated in the document. It requires the VTS operator to monitor maritime safety and ensure the protection of marine environment issues. Also, VTS operators have to check and co-ordinate with relevant parties within and outside the VTS center in order to enforce the legislation.

In addition, the operational concept was initially designed when implementing the VTS at the beginning of VTS phase 1 of Sriracha VTS. It is clearly stated that there are a number of authorities in Thai government involved in marine environment protection. As a result, the responsibilities tend to be very complex. Therefore, the VTS center is able to take immediate action to protect the adverse effects of incidents and accidents that cause marine environmental issues.
4.1.5 Collecting and recording the real-time traffic information

According to the Announcement of Marine Department, No.229/2557 on the recruitment of officials, it states evidently that, in terms of services, VTS operators are required to collect and record the principle statistics of maritime traffic. These data will generate the report in order to support decision making for maritime policy of the maritime administration, Marine Department. These data enable the officials to analyze the maritime casualties as well as VTS center’s preparedness. Besides, it is clearly seen in the Terms of Reference for Vessel Traffic Management and Information System that the maritime traffic statistics should be used for the maritime traffic operations of the VTS system.

4.2 Findings on Thailand VTS’s critical limitations and gaps

In this section, the findings on Thailand’s critical limitations and gaps are explored by conducting interviews. This kind of technique is apparently to give more substance and to reveal detailed information. This is because the qualitative research is concerned with attempting to achieve a clear understanding of the problem. With the semi-structure interview and open-ended question, it is able to understand how participants think and how the gaps exist in the realistic perspective.

This section of the research was conducted through individual interviews as described in chapter 3. The data collected was presented in a narrative and pattern form that includes the description and analysis of data. The findings from interviews are organized into four sub-sections including participants overview, the compliance of VTS to VTS guidelines and recommendations leading to gaps, important mechanism of VTS components and improvement of Thailand VTS.
4.2.1 Participants overview

The researcher interviewed the participants, who are VTS operator in Thailand based on the purposive sampling technique as explained in chapter 3. With the ethical consideration, the interview is on a voluntary basis and anonymous. As a result, the English alphabets were assigned as a sequence of the participants. The background and experience of the participants can be summarized as below:

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Summary of background and experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Government employee, Bachelor degree in science and technology field, 6 years VTS operator experience, IALA V103/1, Non-seafarer, Motivated by VTS as a new career in Thailand</td>
</tr>
<tr>
<td>B</td>
<td>Government official, Bachelor degree in business field, 5 years VTS operator and 2 years VTS supervisor experience, IALA V103/1, Non-seafarer, Motivated by VTS as a challenge job</td>
</tr>
<tr>
<td>C</td>
<td>Government official, Master degree in Maritime Affairs, 5 years VTS operator experience, Internal training course, Air traffic management background, Non-seafarer, Motivated by VTS as beneficial and challenges</td>
</tr>
<tr>
<td>D</td>
<td>Government official, Bachelor in engineering field, IALA V-103/1</td>
</tr>
<tr>
<td>E</td>
<td>Government employee, 4 years VTS operator and 2 years VTS supervisor experience, IALA V-103/1, IALA V-103/2, Non-seafarer, Motivated by VTS because it is believed that working as VTS will be easily promoted in Thai government system</td>
</tr>
<tr>
<td>F</td>
<td>Government official, 2 years VTS operator experience, OJT, Non-seafarer, Motivated by VTS as challenging in communication skill and new career in Thailand</td>
</tr>
<tr>
<td>G</td>
<td>Government official, 4 years VTS operator and 2 years VTS supervisor, IALA V-103/1, IALA V-103/2, Seafarer, Motivated by VTS as complexity of equipment and multiple skill of VTS operator</td>
</tr>
<tr>
<td>Sequence</td>
<td>Summary of background and experience</td>
</tr>
<tr>
<td>----------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>H</td>
<td>Government official, Bachelor degree, 4 years VTS operator and 2 years VTS supervisor experience, IALA V-103/1, IALA V-103/2, Seafarer</td>
</tr>
<tr>
<td>I</td>
<td>Government employee, Bachelor degree, 1 year VTS operator experience, OJT, Seafarer</td>
</tr>
<tr>
<td>J</td>
<td>Government employee, Master degree, 5 years VTS operator experience</td>
</tr>
<tr>
<td>K</td>
<td>Government official, 4 years VTS operator and 2 years VTS supervisor experience, GMDSS certificate, IALA V-103/1, IALA V-103/2, Seafarer, Motivated by VTS as it gets involved in maritime traffic safety and helping people from distress situation</td>
</tr>
</tbody>
</table>

Table 2: Summary of background and experience

Table 2 suggests that the participants are classified into two types including government official and government employee. Government official is a permanent position, while government employee is employed for a temporary period of time. Most participants are bachelor degree graduates, while others have a master’s degree. Only 50% of the participant were trained properly in accordance with IALA model course, while others were trained by OJT only. Furthermore, all of them are motivated by the characteristics of VTS duties and the challenges.

### 4.2.2 Compliance of VTS and its gaps

In this section, the researcher interviewed the participants according to the compliance of VTS compared with international guidelines and recommendations. These are the gaps of the Thailand VTS which are considered to be a critical limitation of VTS in Thailand that holds back development. The participants’ opinion can be summarized as below;
<table>
<thead>
<tr>
<th>Sequence</th>
<th>Opinion on Thailand VTS’s critical limitation and gaps</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>“We do not have any training center for being a VTS operator. The training is not following the IALA model course and the focus of duties and job description of VTS personnel is insufficient. Thailand should focus on training and rebuilding personnel who are qualified with IALA model course because Thailand VTS has insufficient VTS personnel to operate efficiently.”</td>
</tr>
<tr>
<td>B</td>
<td>“We are trying to follow the international guidelines from IMO and IALA but they have not been covered comprehensively. However, the VTS personnel are not mostly qualified because of the factors and processes including recruitment, qualification, and training process and measurement.”</td>
</tr>
<tr>
<td>C</td>
<td>“In my opinion, it is not totally yes or no. Many elements are in conformity with IMO and IALA standard, while some are not. However, if I need to choose only one answer, I would say yes, Thailand VTS has complied with international guidelines and recommendations.”</td>
</tr>
<tr>
<td>D</td>
<td>None</td>
</tr>
<tr>
<td>E</td>
<td>“The training course of VTS personnel should produce more expertise of VTS personnel actually. However, the development of management and VTS personnel are insufficient. In addition, the standard operating procedures are not in line with current situation of VTS operation.”</td>
</tr>
<tr>
<td>F</td>
<td>“VTS personnel is insufficient for services. The maintenance of VTS equipment are not really comply on the guidelines. Moreover, the understanding of VTS personnel is deviated from the objective of VTS. This is because the standard operating procedure is not yet put in place properly.”</td>
</tr>
<tr>
<td>G</td>
<td>“New training program has not yet complied with IALA model, while the recruitment of VTS personnel is insufficient currently. Moreover, there is no motivation for VTS personnel.”</td>
</tr>
</tbody>
</table>
**Table 3: Opinion on Thailand VTS’s critical limitation and gaps**

Table 3 shows that there are four findings mentioned frequently in the interview processes. Those findings were analyzed and summarized into themes. Thereby, it includes the lack of training center and program in Thailand, the nonconformity of IALA model courses, and inadequate VTS personnel.

Only two participants mentioned that the training center of Thailand is not yet well established. Four participants mentioned that Thailand VTS has not yet completely compiled with the IALA model course for training, while five participants mentioned that VTS personnel in Thailand are insufficient. Furthermore, one of the participant
suggested that Thailand VTS has already compiled with IALA guidelines. However, there was one participant who has no opinion in this matter.

### 4.2.3 Important mechanism of VTS components

In this section, the important mechanism of VTS components were investigated from the interviews. It provides the insight of the framework that participants are focusing on. It summarized below:

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Opinion on important mechanism of VTS components</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>“VTS personnel is the most important than others because if we have the personnel who have a base knowledge following IALA and IMO, it must be easier to create the strong organizational structure, legislation and operational procedure.”</td>
</tr>
<tr>
<td>B</td>
<td>“All components are equally important including legislation, organization, personnel. These all have to be working in the same direction in order to be accepted from international community.”</td>
</tr>
<tr>
<td>C</td>
<td>“I think VTS personnel is the most important factor.”</td>
</tr>
<tr>
<td>D</td>
<td>“VTS personnel have to be person who are able to work properly. They also have to understand the legislation, regulation and procedure in order to avoid the mistake and work precisely.”</td>
</tr>
<tr>
<td>E</td>
<td>“Personnel because if there is no personnel working in proper position, the organization and operation cannot be operated.”</td>
</tr>
<tr>
<td>F</td>
<td>“Organization because if there is no organization, the objective of following the SOLAS will not be achieved.”</td>
</tr>
<tr>
<td>G</td>
<td>“Personnel because personnel is the main factor involving in reducing the maritime incidents and accidents.”</td>
</tr>
<tr>
<td>H</td>
<td>“Legislation and regulation are the main factor of VTS framework leading to the effective organization and VTS personnel.”</td>
</tr>
</tbody>
</table>
### Table 4: Opinion on important mechanism of VTS components

Table 4 presents the findings on the importance of mechanism from 10 participants. It can be clearly observed that there are five main mechanisms which are mostly mentioned. It includes VTS personnel, organization, legislation and standard operating procedure. VTS personnel was mentioned frequently for 6 participants as they saw that VTS personnel is the main factor of operating the VTS. Two participants mentioned that organization and legislation respectively, while only one participant saw that standard operating procedures is the most important.

#### 4.2.4 Improvement of Thailand VTS

In this section, the researcher perceived the opinion of participants relating to the improvement of Thailand VTS in the future. The opinion can be the data for suggesting how the organization should be in the day to come.
Table 5: Opinion on improvement of Thailand VTS

Table 5 investigates that the participants have different ideas suggesting on the improvement of Thailand VTS in the future. Most of participants mentioned frequently the VTS personnel and the skills of people who are working in VTS operations. They considered that by having qualified, skilled-VTS personnel will drive the organization going successfully forward in the future. Some of them though that the structure of
VTS organization is not modern and will suit the current situation. As a result, they believe that by having a well-structured organization, it will lead the path of the organization to a success point.

4.3 Summary

This chapter presents the findings on the roles of VTS in terms of its capability to enhance the safety and efficiency of navigation and the current ongoing situations using the documentation review and the exploration of critical limitation and gaps of Thailand VTS using the interview method with purposive sampling techniques.

From the analysis of the expert opinions, it can be stated that there are a number of roles of VTS in Thailand. This includes monitoring the maritime traffic through the total surveillance system, increasing the awareness of incoming and outgoing vessels through maritime traffic, facilitation of the coordination and maritime parties, the prevention of possible environmental pollution and collecting and recoding the real-time traffic information. Nevertheless, there are evidently findings that the standard operating procedure of some VTS operation as described in chapter 2 are not well defined according to the IMO and IALA guidelines and manual. It shows that external and internal procedures have not yet been completed.

There are findings on the critical limitation and gaps of Thailand VTS. This includes the lack of a training center and program in Thailand, nonconformity of the IALA model course, and inadequate VTS personnel. In addition, VTS personnel has been mentioned frequently as the most important component of VTS. Therefore, it can be shortly summarized that most of the participants considered that the critical limitation of Thailand VTS is all about the VTS personnel and its training in connection with IALA guidelines and recommendations.
Chapter 4 summarized and presented the data analysis and research findings obtained within two different data collection categories including documentation and interviews using qualitative data analysis. It identified and highlighted some critical limitation of VTS implementation in Thailand as well as the roles of Thailand VTS in terms of its capability to enhance the safety and efficiency of navigation and the current situations.

In this chapter, it is devoted to providing a critical discussion of the findings and initial analysis, from the previous chapter, against the existing literature and research methodology in chapters 2 and 3 respectively.

5.1 Critical Discussion

The overall aim of this research is to perceive the roles of the VTS in terms of the capability to enhance the safety and efficiency of navigation, current ongoing situations as well as to explore the critical limitations and gaps. In order to achieve these specific aims, the findings are discussed critically in connection with the corresponding research objectives and questions.
5.1.1. Research Question 1

What are the roles of Thailand VTS in terms of its capabilities to enhance the safety and efficiency of navigation and the current ongoing situation?

The analysis of the findings shows that the VTS in Thailand has a number of roles in enhancing the safety and efficiency of navigation. It includes the monitoring of the maritime traffic through the total surveillance system, increasing the awareness of incoming and outgoing vessels through maritime traffic, facilitation of the coordination among allied services and maritime parties, prevention of the possible environmental pollution and collection and recording of the real-time traffic information.

As noted from the literature review, it can be explicitly seen that VTS is a service that the authority provides to improve the safety and efficiency of vessel traffic as well as protect the environment. Such services shall deal with traffic situations in a specific area capably and appropriately.

For this reason, the VTS contributes to maritime safety by enthusiastically monitoring the maritime traffic through the VTS’s components. This is because VTS operators provide the necessary information to participating vessels for its safe and efficient passage, for example by providing the traffic information in order to avoid the potential, serious incidents and accidents using the communication system. Furthermore, the VTS operator provides the traffic organization and navigational assistance in connection with legislation appropriately. The findings obtained from the data collection can be perceived so that Thailand VTS has a role in monitoring the vessels through the surveillance system in accordance with the specific terms provided by IMO. It is strengthened by the result of Praetorius (2012) that maritime safety can be enhanced by monitoring the maritime traffic. Furthermore, it is supported by the
objectives provided by IMO (1997) that the benefit of implementing the VTS is to monitor the vessels accordingly.

The second finding of the role of VTS in Thailand is to increase the awareness of incoming and outgoing vessels. This can be discussed when considering the ranges of services including INS, TOS and NAS provided by VTS. These services are dealing with the traffic situation, where the traffic image is generated by the technical aspects of the VTS personnel and vessels. Thereby, it is based on the individual perspective of the VTS operator. For this reason, the VTS operator uses navigational information such as making decisions regarding the weather report, traffic, aids to navigation, other special hazards of navigation, and port conditions to operate the VTS system through the surveillance system as well as communicate between vessels in order to keep them aware of such information.

However, with the natures of these information, they keep changing over a period of time. As a result, it is very important to be notice the dynamic changing in the situation in order to deal with those maritime situations properly and rapidly. By having the recognition of the situation early, the vessel can be aware and prepare itself from a potential incident and accident. Furthermore, the vessel is able to make a decision based on the supporting information from VTS in time, both effectively and efficiently.

Therefore, it is undeniable that the increase of the awareness of vessels enhances the safety and efficiency of navigation. To support this finding, Wiersma (2010) supports that creating the situation awareness of VTS perspective enables the VTS operator and vessels to operate safely. Another author (Hughes, 1998) supports that informing in advance, means creating awareness, helps to prevent surprises and enhances the efficiency of maritime safety.
The third finding for the role of VTS is to facilitate the coordination among allied services and maritime parties. Thailand VTS has coordinated with allied services and maritime parties in order to provide the comprehensive flow of both information and operation. For example, when a serious traffic situation appears, there must be some means of effective law enforcement. This is one of the most difficult areas because VTS has to synchronize traffic movement and coordinate with related maritime law enforcement agencies to enforce or assist the particular case rapidly. Another example is any case of a potential accident. Thailand VTS uses its surveillance system to communicate for the mission with allied maritime parties. This communication helps to reduce the potential loss from the delay of operation. Without the proper and well coordination, VTS cannot effectively intervene into the traffic flows and assistance would not be possible and could even be contra-productive.

The finding that there is synchronization within organization of Thailand VTS is corresponds with the routine duties of VTS and its main purpose, meaning that VTS is a coordinator. Therefore, it is undeniable that facilitation among allied services and maritime parties is an important role of VTS. This is strengthened by the study of Rattanasathien (1991), who investigates that VTS is performing as a traffic coordinator by working jointly with either allied services and related maritime parties to make the flow of traffic movement. Furthermore, Praetorius, Hollnagel, & Dahlman (2015) support that VTS can be working smoothly by coordinating and synchronizing within the operating conditions between the vessels and parties.

The fourth finding is to provide the protection of possible environmental pollution. Thailand VTS uses the surveillance system to monitor the maritime traffic as well as the marine environment in a specific area of VTS. This is because the protection of environment can be derived by monitoring maritime traffic. For example, VTS is able to visually see a harmful event when the ship is in operation and there is marine and air pollution involved. Another example is that VTS is able to use communication systems to communicate and receive the report of harmful activities such as oil spills,
emission of polluting gases in a specific area, thereby being able to coordinate with the relevant parties rapidly. This helps to reduce the potential environment and economic loss.

Despite the fact that IMO (1997) states the definition and benefits of VTS, it is able to improve the protection of the environment with a rapid response to the situation, a few researchers (Hughes, 1998; Praetorius, Hollnagel, & Dahlman, 2015) consider that the role of VTS in providing protection of the environment is an additional purpose of VTS. This is because the main purpose of VTS is to monitor the vessel in order to enhance the safety and efficiency of navigation. However, if environment pollution occurs, it might construct the difficulty to the fairways followed by the eventual delay of traffic. Therefore, it can be said that VTS plays a significant role in providing the prevention of environment correspondingly.

The fifth finding is to collect and record the traffic information. Thailand VTS has an internal system to record the movement of traffic and the statistical data, which allow the related parties to use. This is because such information can be utilized for a specific purpose including instant replay during normal operations, reviews of an accident for investigation, evidence, technical evaluation, monitoring and checking the performance of system, statistical analysis of traffic patterns, and training purpose. For example, Thailand VTS does the analysis of a potential incident based on the collected data for future development and support the information to other related parties. In addition, the statistical data of VTS services is counted in order to measure the overall performance of VTS.

By considering the guidelines of IMO (1997) and IALA (2016), it can be clearly seen that the collecting and recording the maritime traffic information can be stated in the operational procedure. This is because the operational procedure guides the VTS operator to operate precisely, which contributes to the flow of operation. It serves the purpose of VTS’s main purpose.
Despite the fact that the role of collecting and recording the maritime traffic data is not the main purpose of VTS, it is additional advantage supporting the operation of VTS. Moreover, it helps to prove in justifying the actions of VTS in an analysis of maritime accident as well as improving the efficiency of VTS operation. Therefore, this is linked to the enhancing of efficiency of navigation.

To conclude, the analysis shows that there are a number of roles in enhancing the safety and efficiency of navigation in Thailand. VTS plays these roles significantly in order to provide the VTS services and functions properly. These services and functions are performed in different means based on the operational procedures and national legislation. Among these roles together with functions and services that VTS carries out, there are contributing to, thereby, and enhancing the safety of navigation, safety of life at sea, efficiency of navigation, protection of marine environment, as well as supporting law enforcement, maritime security and search and rescue mission. Without the linkage of each role, the VTS might not work efficiently and successfully.

5.1.2. Research Question 2

What are the gaps remaining in Thailand VTS?

The initial analysis and findings, from both documentation and interviews in the previous chapter, suggest that there are gaps and critical limitations in Thailand VTS. These limitation and gap can be explored by observing the insight current situation, while the gap can be reviewed by considering the compliance of Thailand VTS with international guidelines and manual of IMO and IALA respectively. The gap and critical limitation include the incompleteness of standard operating procedures, lack of VTS personnel training center in Thailand, nonconformity of IALA model course for training program and inadequacy of VTS personnel.
Firstly, when considering the incompleteness of standard operating procedure of Thailand VTS, it can be explicitly noted from the literature review in chapter 2 that the objectives of VTS can be met on through a number of roles of VTS, especially the coordination and cooperation among the players in the service’s domain. This is because those particular roles can be achieved through the reliability of the information provided by VTS. It depends on the assured availability, quality of services and continuity provided by all relevant parties.

In contrast, if the standard operating procedures are not properly defined and documented, it creates the ambiguous and unreliability of information potentially, which leads to greater mistakes in making a decision by the VTS personnel. Furthermore, it cannot be assured the quality of the services provided by the VTS essentially. For example, the decision made by a VTS operator in Thailand can be delayed because of the lack of standard operating procedures to be referenced. This is inconsistent, and a negative gap compared with international guidelines and practices.

Therefore, documenting the standard operating procedure in a proper manner provides the high quality of services and the VTS’s objectives. The benefits resulting from having a standard operating procedure documented are generally recognized and supported by Nuutinen, Savioja, & Sonninen (2007) and IALA (2016). Some of them include enhancing the quality awareness within the VTS organization, prompt effective action, continual process improvement and increasing productivity and efficiency.

Secondly, the focus needs to be set on the gap of presently missing the training facilities or training center of the VTS in Thailand. It can be discussed by considering the guidelines given by IMO (1997). It clearly states that authorities need to establish themselves for requirement and suitability standards. Nothing in the guidelines derogates from the power or imposes any obligation on authorities. Theoretically, the
Thailand VTS is able to prepare itself by establishing the VTS training center with its own requirements.

Although the requirements can be generally set by the authorities, the major factor in the efficient operation of a VTS center is the standard of competence of its VTS personnel. As a result, the authority should ensure that the VTS personnel can be trained properly in order to operate the VTS in accordance with the roles discussed earlier. This is because it is linked to the principal goals and roles of the VTS in enhancing the safe, efficient and environmentally friendly movement of vessel traffic.

With this perspective, together with high investment and lack of expertise in Thailand, Thailand VTS can find another approach to train the VTS personnel in order to ensure the competence of VTS personnel instead of establishing the in house VTS training center. There are a number of mechanisms that training can be performed. For example, sending the personnel to be trained in qualified and well-known institution alternatively. Moreover, current training schemes differ between basic training and area specific training. While basic training is often provided through centralized training institutions, the area-specific training is usually provided through on-the-job trainings in the particular VTS center of the operators’ future positions. Therefore, it is not implicated that the lack of a VTS training center in Thailand becomes a gap when comparing with specific international guidelines.

Thirdly, when considering the IALA model courses for training and VTS personnel, the following can be concluded. The analysis shows that 70% of participants observed that the current training program of VTS personnel in Thailand has not yet compiled with international guidelines of IMO and IALA, while 40% observed that the VTS personnel in Thailand VTS is insufficient. These need to be discussed in various aspects and points of view including how to implement the outline framework of IMO and IALA, the nature of structural organization and the competencies of personnel.
As noted from the literature review in chapter 2, the IMO (1997) and IALA (2016) outline the frameworks and steps that should be taken by VTS authority to ensure that the VTS personnel are sufficiently competent to operate and fulfill the related VTS’s tasks. This is because the VTS personnel should assist vessel traffic by providing the services including INS, TOS and NAS. It has to be ensured that VTS personnel are qualified and trained appropriately and available to undertake the commitments precisely. For this reason, the VTS operator and supervisor training should be carried out in accordance with the appropriate IALA Model course especially the IALA Model Course V-103/1 – VTS Operator training and V-103/2 – VTS Supervisor training.

However, in the Thailand VTS, the construction of model courses that VTS in Thailand provides are based on the local necessity of the organization, while there is no quality management to be approved. This is because the framework allows the authority to set the skill, specific knowledge and personal suitability standards which the personnel have to meet. Therefore, Thailand VTS is able set itself for training program. As a result, there is no quality management program to assure that the commitments of personnel are precise. This leads not only to the uncertainties of performance and professional responsibility, but also the number of qualified VTS personnel eventually.

Another factor affecting this gap is that of the nature of organization. VTS in Thailand is established based on the policy of the government. The organization is governed by the Marine Department, which is a governmental organization. Therefore, the process of development is generally slow because of the hierarchy of the structure. This leads to difficulties of the recruitment and selection standard of the VTS personnel, thereby it affects the number of VTS personnel.

To summarize, it can be explicitly seen that there are a number of gaps and critical limitations of Thailand VTS. Some of them are the gaps, while some of them are not when considering the international guidelines. However, it is principally that these
international guidelines are not mandatory or impose the power of authority. They are encouraged to be followed because of the conformity of standards. Obviously, the guidelines, although not legally binding, widely contribute to a globally harmonized provision of the VTS services.

The identified gaps for the case of Thailand VTS include the incompleteness of standard operating procedures, the nonconformity of the IALA model course for the training program and the inadequate situation of VTS personnel. This affects potentially the reliability and availability of the performance and responsibilities, thereby affecting to the safety and efficiency of navigation. Additionally, another finding is the lack of a training facilities in Thailand. This is not considered to be a critical limitation based on the necessity of Thailand VTS and compliance of international guidelines. Thailand VTS is able to find an alternative way to send these personnel to be trained in an alternative specific and qualified institution, while the quality of training remains standard.

5.1.3. Research Question 3

*How should Thailand VTS improve itself by bridging those gaps?*

In reference to the critical discussion of research question 1 and 2 above, the roles, gaps as well as critical limitation of Thailand VTS were discussed against the literature review in chapter 2. This provides the rationale behind how it affects to the implementation of VTS system. Despite the fact that the international guidelines are not mandatory, but it is urged to follow because of the conformity of the standard worldwide. Therefore, with the identified gaps above, it can be discussed how to bridge the gaps in order to improve the standard and finally enhance the safety and efficiency of navigation at long last. The bridging of gaps can be discussed based on the international guidelines and manuals given by IMO and IALA. These gaps include the
incompleteness of standard operating procedures, the nonconformity of the IALA model course for training program and the inadequacy of VTS personnel.

Firstly, when considering the standard operating procedure, it is an integral part of verifiable safety management system for VTS (IALA, 2016). This is because it can ensure that the standards set for types of services are consistently maintained and those services are delivered safely and effectively in accordance with the examined roles.

In order to bridge the gap, incompleteness of standard operating procedure, Thailand VTS should develop operational procedure to achieve the standardized operation and performance by clearly and specifically defining the operating procedure. The standard operating procedure should be documented in manuals, available to all personnel.

Based on the literature review, there are two different operational procedures including internal and external operational procedure. Internal procedure is dealing with the day to day running of the VTS center, while external operational procedures are dealing with the interaction with participating vessels and allied serviced. The examples of internal operational procedures are gathering and recording of information, operational staff, public relation, system failure, personnel medical emergencies and security incidents. The examples of external operational procedures are pre-arrival information, vessels entering, vessel transiting, vessels at berth, vessels at anchor, vessels departing, environmental conditions. Most of the operating procedure should have been designed to meet international standards.

By completing the standard operating procedure, Thailand VTS can improve itself by referring to the IALA Recommendation V-127, which provides a reference list to aid the VTS center to determine the main factors which should be appraised when documenting the standard operating procedures. However, this guideline is not mandatory or exhaustive. It is recommended to be adapted for suiting the individual needs and local conditions.
In the IALA Recommendation V-127, it is recognized that the nature of VTS’s tasks and activities to be carried out will depend on the capability of the VTS and also the type of services to be provided. This is because each VTS center will have its own power under the national laws and regulations. Therefore, it is undeniable that having clear and well documented standard operating procedure benefits to the VTS center. For example, it produces reliable and accurate measure in making a decision. In addition, the standard operating procedure is a part of key elements of a VTS quality management system, which leads to an increase in the productivity and efficiency of the whole organization.

Secondly, when considering the nonconformity of IALA model courses for training program and inadequacy of VTS personnel, Thailand VTS can develop itself by initially focusing on the training section of IMO resolution A.857 (20). This is because it provides the guidance on the training of VTS personnel generally. Also, it is advised to establish concomitant training standards of the training. These training standard should form the basis of training program to be developed and provided to VTS personnel effectively.

According to the general provisions given by IMO (1997), all personnel should obtain a qualification of VTS before being considered competent to operate as VTS operator or supervisor. It is required that VTS authority should provide appropriately qualified, sufficient staff, suitably trained and capable of performing the tasks required. As a result, it is anticipated that a number of model courses given by IALA are planned aimed at setting out the requirements for basic training.

In order to ensure that the standard of training of VTS personnel meet the appropriate level, Thailand VTS should provide the necessary accreditation and approval of the training program in accordance with IALA Guidelines No.1014 on the Accreditation and Approval Process for VTS training. This is because Thailand VTS has to ensure the conformance with the requirements and standards of VTS training. By following
these guidelines, it can be structured well in accordance with established training procedures and able to easily conduct, monitor, evaluate and support the training processes successfully.

In addition, it is recommended to bring the model courses adopted by IALA to undertake for the training program of Thailand VTS including Model Course V-103/1 VTS Operator, Model Course V-103/2 VTS Supervisor, Model Course V-103/3 On-the-Job-Training (VTS Operator and VTS Supervisor), and Model Course V-103/4 VTS On-the Job Training Instructor to attention for training VTS personnel. This is because it generally describes the principles and objectives of VTS training, proposes entry standards and aptitude testing specifically. Also, it enables Thailand VTS to construct the training model courses in connection with individual needs appropriately, while interaction of international harmonization and standard is remained.

Thailand VTS should design the training course based on the structure of the particular mode courses recommended by IALA. Moreover, this is linked to the system’s parameters, where the recruitment and qualification of personnel are considered, for example the level of qualification, skill, knowledge affects the training requirement at last. This is strengthened by the study of Abdulla (2011), IALA (2016) and Patraiko FNI (2018) that authorities should provide training courses for VTS to the highest international standards recommended by IALA and in line with the types of services. Additionally, it can be supported along with the examples of Asian countries such as Singapore, Indonesia, and Japan, where they use the IALA Model courses for setting their own minimum standard.

To sum up, Thailand VTS can bridge the identified gaps by considering these recommendations specifically the IALA model courses training programs. These programs should be constructed based on the guidelines, which provide the forming of a standard on the training structures. For this reason, Thailand VTS can conduct, monitor, evaluate the curriculum and organize effectively. These international
guidelines include IALA Guidelines No.1014, Model Course V-103/1 VTS Operator, Model Course V-103/2 VTS Supervisor, Model Course V-103/3 On-the-Job-Training (VTS Operator and VTS Supervisor), and Model Course V-103/4 VTS On-the-Job Training Instructor. In addition, Thailand VTS should follow the IALA Recommendation V-127 in order to ensure that all standard operating procedures of VTS centers are in place effectively. This will enable Thailand VTS to increase the quality of services and be a part of quality management in the future.
CHAPTER 6
CONCLUSIONS AND RECOMMENDATIONS

Chapter 5 presented the interpretation and discussion in light of the research questions and objectives. It was also discussed against the literature correspondingly.

This chapter presents the conclusions resulting from this study. A number of recommendations are presented thereafter. Therefore, this chapter is organized into 2 sections including conclusions and recommendations.

6.1 Conclusions

This research aimed to determine the roles of Thailand VTS in enhancing the safety and efficiency of navigation as well as investigate the critical limitations and gaps of implementation the VTS system. In addition, it also aimed to develop the proper suggestion for the implementation of VTS in Thailand.

In the research, there were several sources of data collection including primary data and secondary data for analysis. The primary data was obtained by conducting the in-depth interviews with purposive sampling technique of active VTS operators in Thailand as well as management officials, who are highly experienced. The secondary data comprised of the relevant literature including various kind of Thai government legislation and policy, VTS procedures and announcements, training materials, supporting documents, VTS job descriptions, organizational charts, and other relevant
documents. These combined sources of data supported the analysis of the research in the qualitative research method principally.

The initial research findings revealed that there were 5 main roles of VTS in the implementation that are contributed to the safety and efficiency of navigation. This includes monitoring the maritime traffic through the total surveillance system, increasing the awareness of incoming and outgoing vessels through maritime traffic, facilitation of the coordination among allied services and maritime parties, prevention of possible environmental pollution and collecting and recording the real-time traffic information.

Thailand VTS is playing the important roles in management of maritime traffic approaching and leaving Thai waters, by monitoring through total surveillance system with the support of precisely and timely data. These data are collected and recorded as real-time traffic information for further investigation and performance improvement. In addition, it also supports the coordination among the related parties in order to enforce the national law such as environmental protection. These roles are evidently contributed to the safety and efficiency of navigation in the Thai waters.

However, the research findings also suggest that there are a number of gaps, by comparing with international guidelines, available in the implementation of VTS in Thailand. This includes the incompleteness of the standard operating procedure for VTS, the nonconformity of IALA training model course and inadequate of VTS personnel. Without any doubt, these gaps are needed to be bridged for future improvement. This is because those gaps are potentially affecting to the quality of services provided by the VTS. This will contribute to the safety and efficiency of navigation in Thai waters as well.

The study concluded that by operating the roles of VTS successfully, Thailand VTS has to improve itself to meet the set of standards and ensure that the quality of services
is delivered effectively to vessels. In order to achieve such quality, Thailand VTS can bridge its gaps by following the conformity of the standard provided by IMO and IALA. These include especially the international guidelines on the IALA Recommendation V-127 – Operational Procedures for VTS for standard operating procedure of VTS and IALA Guidelines No.1014 on the Accreditation and Approval Process for VTS training and IALA Recommendation V-103 for VTS personnel training.

In addition, it is believed that the implementation of VTS in Thailand, with strong compliance of the standard recognized by international organizations, will support the identified roles of VTS in Thailand. It will help to reduce the risk of navigation and marine environment, the thereafter increase the efficiency of navigation within Thai waters at long last.

Finally, it is to be mentioned that some of the results from the research carried out in this dissertation have contributed to papers presented at “International Navigation Simulator Conference (INSLC)” (Baldauf et al., 2018) and “The 25th International Maritime Lecturers Association Conference (IMLA25)” (Baldauf et al., 2018b) respectively.
6.2 Recommendations

As a result of the research, it is strongly recommended, based on the case studies of successful countries, that the following policies are purposed:

5.3.1 Standard Operating Procedures have to be defined and documented to achieve the standardized operation and performance in accordance with the IALA Recommendation V-127 – Operational Procedures for VTS. The example of standard operating procedure of VTS operation are at table 6.

<table>
<thead>
<tr>
<th>Internal Procedure</th>
<th>External Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Routine Procedures</strong></td>
<td><strong>Routines Procedures</strong></td>
</tr>
<tr>
<td>- Operational Staff</td>
<td>- Pre-arrival information</td>
</tr>
<tr>
<td>- Training</td>
<td>- Entering and departing of vessels</td>
</tr>
<tr>
<td>- Collecting and Recoding VTS</td>
<td>to the VTS area</td>
</tr>
<tr>
<td>Information</td>
<td>- Anchor/berth of vessels</td>
</tr>
<tr>
<td>- Equipment operation and maintenance</td>
<td>- Vessels transiting VTS area</td>
</tr>
<tr>
<td>- Interaction with allied services</td>
<td>- Environment conditions</td>
</tr>
<tr>
<td>- Security</td>
<td>- Waterway conditions</td>
</tr>
<tr>
<td>- Watch handover</td>
<td></td>
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<tr>
<td>- Vessel handover</td>
<td></td>
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<tr>
<td>- Public relations</td>
<td></td>
</tr>
<tr>
<td><strong>Emergency Procedures</strong></td>
<td><strong>Emergency Procedures</strong></td>
</tr>
<tr>
<td>- Internal emergencies</td>
<td>- Collision, Grounding, Fire</td>
</tr>
<tr>
<td>- Forced evacuation</td>
<td>- Pollution</td>
</tr>
<tr>
<td>- Personnel medical emergencies</td>
<td>- Medical emergencies</td>
</tr>
<tr>
<td>- Security incidents</td>
<td>- Security incidents</td>
</tr>
</tbody>
</table>

Table 6: Example of VTS operational procedures
5.3.2 An urgent proposal should be initiated to international agencies, for instance IMO, for adopting a “Mandatory Reporting System” in the upper Gulf of Thailand and publish in proper nautical publication.

5.3.3 The scope of accountability and liability of VTS personnel in Thailand should be taken into consideration in accordance with national law and internal procedures in case of accidents in the VTS area.

5.3.4 In order to provide suitable measures to monitor, supervise and manage the navigation in the VTS area effectively, the VTS regulations and procedures should be re-evaluated and well defined.

5.3.5 Thailand VTS should ensure the objectives of the VTS are effectively met and maintain a quality of services constantly to meet not only the international standards but also demands of local maritime traffic. It can be achieved by conducting a proper active quality management system and quality assurance to international standards for VTS systems in accordance with IALA Recommendation O – 132 Quality Management for Aids to Navigation Authorities.

5.3.6 In order to provide the quality of services and ensure the competence of personnel that occupy operational positions in VTS center, Thailand VTS should provide the necessary accreditation and approval according to IALA Guidelines No.1014 on the Accreditation and Approval Process for VTS training. In addition, Thailand VTS should develop itself for training programs especially for VTS operators in accordance with the IALA model course including Model Course V-103/1 VTS Operator, Model Course V-103/2 VTS Supervisor, Model Course V-103/3 On-the-Job-Training (VTS Operator and VTS Supervisor), and Model Course V-103/4 VTS On-the-Job Training Instructor.
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APPENDICES

Appendix 1

Questions for In-depth Interview

Research Title: Thailand VTS: An Analysis of its Capabilities to Enhance Safety and Efficiency of Navigation

(Mainly Active VTS Operator)

Part 1: Understanding the respondents

1. Please tell us your background and experience relating to VTS system?
   Sub-questions

   1.1 What is your employment status in Marine Department of Thailand?

   1.2 What is your age?

   1.3 How many years of working experience in VTS center do you have?

   1.4 What kind of training have you had attended before working as a VTS operator?

   1.5 Do you have a mariner background?

      If “yes”
      1.5.1 In what function? (Licensed Master, Licensed Deck Officer?)
      1.5.2 How many years at sea?
      1.5.3 What is your motivation being a VTS operator?

      If “No”
1.5.4 What is your professional background?
1.5.5 What is your motivation being a VTS operator?

Part 2: Exploring the Thailand VTS’s critical limitation

2. According to IMO and IALA, has Thailand VTS compiled with those recommendations and guidelines?

If “Yes”
2.1 Based on your experience, how do you see potential development of Thailand VTS to fulfill or optimize the challenging in new environment of Thailand VTS?

If “No”
2.2 In your opinion, what do you think that Thailand VTS has not yet compiled?
2.3 In which do you think that it is the most critical problem?
2.4 Based on those compliance, to which extend do you think Thailand VTS should go forward for complying the recommendation?
2.5 Do you see any further measure to improve? How?

3. According to IMO and IALA’s guidelines, based on your experience, what is the most important mechanism of VTS’s components?

4. How do you define the rules, regulation regarding the operation of VTS?

5. In your own perspective, in the current situation, do you think that recruitment, qualification, and training process and measurements in preparing personnel to operate VTS efficient and sufficient?
Sub-questions

5.1 Based on your experience, what are those minimum qualifications of VTS operator to perform the duties?

5.2 How do you attend the training course for VTS operator?

5.3 Is re-qualify as a VTS operator required?

5.4 Are there additional training requirements that you will recommend to enhance VTS’s proficiency?

6. Can you draw picture of how do you think the VTS operation should be organized effectively?

**Part 3: Observing the potential development of VTS in Thailand**

7. Do you have any additional requirements that you would recommend to carry out in order to have effective VTS in Thailand?

8. How do you perceive Thailand’s VTS in the next 10 years?
Appendix 2
Interview Consent Form

Research Title: Thailand VTS: An Analysis of its Capabilities to Enhance the Safety and Efficiency of Navigation

Researcher’s Name: Mr. Theeratch Amphanthongpaphakul

Research Participants name:

Thank you for agreeing to be interviewed as a part of the research. Ethical procedures for academic research undertaken from World Maritime University (WMU) require that research participants explicitly agree to being interviewed. This consent form is necessary for researcher to ensure that you understand the purpose of the involvement and that you agree to the conditions of your participation.

Objective of study

The overall objective of this interview is to explore and gather the necessary data to complete the dissertation for a Master of Science in Maritime Affairs (Shipping Management and Logistics) at World Maritime University (WMU) for the topic “Thailand VTS: An Analysis of its Capabilities to Enhance the Safety and Efficiency of Navigation”. The purpose of this study is to explore the critical limitation and ongoing situation of Thailand VTS and identifying the gaps remaining that hold back the development. Ultimately, it is also aimed to present the catch-up policy for the related parties to use in the future.
Ethical Declaration

In conjunction with the World Maritime University’s ethical procedure, please be informed that all the data and response collect will be kept classified in a secured manner and shall be merely used for the purpose of research and data analysis, of which they are only accessible to the researchers and with whom he might collaborate as a part of the research process. The interview will be recorded and a transcript will be produced. The data will be anonymous and will be disposed of at the end of the research. Please be advised that the interview will take place around 30 minutes of your time and you are allowed to withdrawn from the interview at any time.

Researcher’s contact: Mr. Theeratch Amphanthongpaphakul, w1701258@wmu.se
Supervisor’s contact: Assoc.Prof. Dr. Michael Baldauf, mbf@wmu.se

Signature of research participant:

Date: