T.C. PÎRÎ REİS UNIVERSITY
INSTITUTE FOR GRADUATE STUDIES

IDENTIFYING KNOWLEDGE GAPS IN MASTER LEVEL BRIDGE TEAM AND RESOURCE MANAGEMENT

MASTER'S THESIS

AHMET FIRAT USTA

JUNE 2023

FOREWORD

Working in the simulation center of Piri Reis University for the time that I have has not only given me invaluable knowledge and experience, but also much to think about. In this period of time I have witnessed the state of maritime education and training, as well as the skill and knowledge of the sailors manning the world's fleet firsthand. Often, I was asked to observe them and on occasion, evaluate them. This has made me curious, is a broader evaluation even possible? Could we create an analytic framework in order to determine the weak points, or the knowledge gaps, of seafarers of today?

This question has become the basis of my dissertation, as I think among the many other questions that I've asked to myself during this time, it is one of the more important ones to answer. By finding the answer to these questions, and pinpointing these knowledge gaps, it becomes possible to focus on them through training and perhaps create a safer environment for all seafarers to work in.

I would also like to take this opportunity to express my sincere thanks to my supervisor Asst. Prof. Dr. Barış Özsever for his invaluable support and mentorship which made it possible for me to see this through even when I thought I couldn't.

APPROVAL of the INSTITUTE for GRADUATE STUDIES

PRU, Graduate Studies Institute's Master’s student “20310101001” and “Ahmet Fırat Usta” prepared his thesis titled

“IDENTIFYING KNOWLEDGE GAPS IN MASTER LEVEL BRIDGE TEAM AND RESOURCE MANAGEMENT”

by fulfilling all the necessary conditions determined by the relevant regulations and successfully presented it to the jury whose signatures are below.

Approval of the Institute for Graduate Studies

(Title and Name)
Director

(Title and Name)
Head of Department

(Title and Name)
Advisor

Examining Committee Members

(Title and Name)

(Title and Name)

(Title and Name)

(Title and Name)

Date of Approval:

ABSTRACT

IDENTIFYING KNOWLEDGE GAPS IN MASTER LEVEL BRIDGE TEAM AND RESOURCE MANAGEMENT

Ahmet Fırat Usta

MARITIME TRANSPORTATION AND MANAGEMENT ENGINEERING MASTER'S PROGRAM

Thesis Supervisor: Asst. Prof. Dr. Barış Özsever

June, 2023, 51 Pages

Bridge team and resource management trainings and evaluations have been a hot topic for the maritime domain for a while. However, studies regarding these topics have largely been about methods of training and/or evaluation, as well as the effectiveness of these methods. A literature review was conducted and a research gap on evaluation results, and as such the knowledge gaps, of today's seafarers was identified. In this dissertation, a method of evaluation is proposed, prepared and carried out utilizing a maritime simulator complex. Firstly, the key topics of bridge team and resource management are identified. Then, simulator scenarios are prepared in order to test the performances of oceangoing masters in these key topics. After this, these scenarios are carried out by participants of oceangoing master rank. Following the simulator applications, a one way analysis of variation is done. This method is chosen due to the nature of the data being one independent variable with multiple dependent variables, and the one way analysis of variation lets us see any relationship between these. The results are then examined in order to determine the knowledge gaps of the participants. It is found that the participants have knowledge gaps in topics of communication, collision prevention and emergency handling. These topics are then more closely examined, and further research is suggested.

Keywords: Maritime simulators, Bridge team and resource management, Knowledge gaps

ÖZET

KAPTAN SEVİYESİNDE KÖPRÜÜSTÜ TAKIM VE KAYNAK YÖNETİMİ BİLGİ EKSİKLİKLERİNİN TANIMLANMASI

Ahmet Fırat Usta

DENİZ ULAŞTIRMA İŞLETME MÜHENDİSLİĞİ

Tez Danışmanı: Dr. Öğr. Üyesi Barış Özsever

Haziran, 2023, 51 Sayfa

Köprüüstü takım ve kaynak yönetimi ile ilgili eğtim ve değerlendirmeler bir süredir denizcilik sektörünün gündeminde bulunmuştur. Fakat, bu konular hakkındaki araştırmalar yoğunlukla eğitim ve/veya değerlendirme metodları ile bu metodların etkinlikleri üzerine olmuştur. Yapılan literatür taraması üzerine bugünün denizcileri hakkında yapılan değerlendirme sonuçları, ve bununla beraber bilgi eksiklikleri tespitleri ile ilgili bir araştırma açığı belirlenmiştir. Bu tezde bir değerlendirme metodu sunulmuş, hazırlanmış ve bir simülatör merkezi yardımıyla uygulanmıştır. Öncelikle, köprüüstü takım ve kaynak yönetiminin ana konuları tespit edilmiştir. Sonrasında, uzakyol kaptanlarının bu konularda performanslarını ölçmek üzere simülatör senaryoları hazırlanmıştır. Bunu takiben, senaryolar uzakyol kaptanları tarafından uygulanmış ve bu uygulamalar değerlendirilmiştir. Son olarak ise yapılan değerlendirmelerin sonuçları tek yönlü ANOVA yöntemi ile değerlendirilmiştir. Bu yöntemin seçilmesisin sebebi tek bağımsız çok bağımlı değişken sayısında bu analizle değişkenler arası ilişkilerin gözlemlenebilmesidir. Elde edilen sonuçlar katılımcıların bilgi eksikliklerinin tespit edilmesi adına incelenmiştir. Katılımcıların iletişim, çatışmayı önleme ve acil durum idaresi konularında bilgi eksiklikleri olduğu tespit edilmiştir. Bu konular daha yakından incelenmiş ve konu hakkında yapılabilecek potansiyel çalışmalar önerilmiştir.

Anahtar Kelimeler: Denizcilik simülatörleri, Köprüüstü takım ve kaynak yönetimi, Bilgi eksiklikleri.

DEDICATION

To my family, who have always supported me through everything.

To my girlfriend, who has been patiently waiting for me.

To my fuzzy familiar, who has been a constant source of joy.

TABLE OF CONTENTS

Abstract...i

Özet...ii

Dedication...iii

Table of contents...iv

List of tables...vi

List of figures...vii

List of abbreviations...viii

1. INTRODUCTION...1

1.1. Motivation………………...1

1.2. The ship master's toolset...1

1.3. A look at the academic discussion..2

2. METHODOLOGY...9

2.1. Simulator applications...11

2.1.1. BTRM key topics...11

2.1.2. The simulator system...13

2.1.3. Designing the simulator scenarios..14

2.1.3.1. Scenario modifiers..15

2.1.3.2. Istanbul Strait..16

2.1.3.3. Rotterdam Approach..19

2.1.3.4. Messina Strait..21

2.1.3.5. Singapore Strait..23

2.1.3.6. Dover Strait..25

2.1.3.7. Tanger-Med Approach..27

2.1.3.8. General information about the scenarios.........................29

2.2. The evaluation process...33

2.3. Participants and simulator applications..34

3. ANALYSIS AND RESULTS...35

3.1. Data homogenity...37

3.2. One way ANOVA analysis......38
3.3. Post hoc test......39
4. DISCUSSION......41
4.1. Determining the knowledge gaps......41
4.1.1. Collision prevention knowledge gaps......41
4.1.2. Emergency Handling knowledge gaps......43
4.1.3. Communication knowledge gaps......44
5. CONCLUSION......45
REFERENCES......46
APPENDIX A......50
CURRICULUM VITAE......51

LIST OF TABLES

Table 1.1: Overview of reviewed literature..5
Table 2.1: Overview of the ship model..30
Table 2.2: Observer education level and sea service...33
Table 2.3: Scoring criteria by point...34
Table 2.4: Number of applications per scenario..34
Table 3.1: Descriptive statistics of the data gathered..35
Table 3.2: Results of the Levene's test...38
Table 3.3: Results of the ANOVA analysis..39
Table 3.4: Results of the Tukey HSD test..40

LIST OF FIGURES

Figure 2.1: The research structure..10
Figure 2.2: The simulator system...13
Figure 2.3: The Istanbul Strait scenario layout...17
Figure 2.4: The Rotterdam approach scenario layout...20
Figure 2.5: The Messina Strait scenario layout...22
Figure 2.6: The Singapore Strait scenario layout...24
Figure 2.7: The Dover Strait scenario layout...26
Figure 2.8: The Tanger-Med approach scenario layout...28
Figure 2.9: The wheelhouse poster of the model ship...31
Figure 2.10: The pilot card of the model ship..32
Figure 3.1: Line graph of the means of key topic scores by scenario....................................37

LIST OF ABBREVIATIONS

AIS	Automatic Identification Systems
ANOVA	Analysis of Variance
BTRM	Bridge Team and Resource Management
COLREG	Convention on the International Regulations for Preventing Collisions at Sea
ECDIS	Electronic Chart Display and Information Systems
GPS	Global Positioning System
HSD	Honestly Significant Difference
IMO	International Maritime Organization
MET	Maritime Education and Training
MOB	Man Overboard
SPSS	Statistical Product and Service Solutions
VTS	Vessel Traffic Services

1. INTRODUCTION

This dissertation consists of four main chapters, the first and the current chapter introduces the topic and develops a research question. The second chapter discusses the methodology of the work. The third chapter deals with the development and the application of simulator scenarios. The fourth and the final chapter presents the results and proposes further discussion.

1.1. Motivation

A great number of resources, research and manpower is focused on maritime education and training (MET), and as the industry grows, the topic only gains importance. To make sure that this great effort is not wasted, efficiency of training is an important subject. In order to increase the efficiency of the training methods however, the subjects where trainees have knowledge gaps must be known. This dissertation aims to determine these knowledge gaps, in order to present areas where MET can focus the effort, increasing overall efficiency.

1.2. The Ship Master's Toolset

The average cargo vessel typically has four deck officers onboard, namely the third and second officers, chief officer and the master. These four people are responsible for the safe planning, reviewing and execution of all operations of the vessel such as navigation, cargo handling and manoeuvring. Arguably though, the majority of this responsibility lies on the shoulder of the vessel's master, the captain, as they will be the first in-line to be held accountable should anything go wrong.

Maritime trade accounts for 80% of the cargo carried around the world (U.N.C.O.T., 2022), from food sources to construction materials, the range and the amount of goods entrusted to the vessel brings about another, hidden type of, cargo with it, the responsibility. The master is responsible not only for his own actions, but for the actions of his officers and crew, and the ultimate safety of them, as well as the ship's.

One way of dealing with this great amount of accountability is to minimize the amount of events to be held accountable for, in a ship master's position, this would be minimizing the amount of accidents. Given how a majority of marine accidents happen due to human error (Corovic and Djurovic, 2013), the ship master is in need of tools to assist him deal with this undertaking. One such important tool is the principles of Bridge Team and Resource Management, or BTRM for short. Bridge team and resource management could be defined as the principles in place in order to utilization of human and technical resources onboard a vessel in order to ensure the safe operation of a ship.

As discussed, BTRM principles are an important toolset for safe operation, and as such, BTRM training is a hot topic within the industry. The ongoing focus on training brings about one question though, exactly where should we focus our training efforts? To answer this question, we would first need to know on which topics does the ship master need training, which parts of the BTRM principles they are lacking knowledge or experience in, if they are. To this end, a review of current literature was conducted to see if this question was already answered.

1.3. A Look at The Academic Discussion

To develop the research question, a literature review on MET, or seafarer assessment using simulators was conducted. The primary goal was to find work that conducts research on the BTRM knowledge gaps in the maritime industry, or suggests frameworks that accomplish this goal. The secondary goals were identified as finding information on the use of simulators for maritime education and training, use of simulators to accomplish the subjects laid out in the primary goals and industry demands on such assessment methods. To this end, keywords "maritime education and training", "seafarer", "assessment", "simulator", "simulation", "bridge team and resource management" and the common derivatives and synonyms of these keywords were used in different combinations. Google Scholar was used as the primary search engine.

Although Google Scholar can be viewed as the most comprehensive academic index (Gusenbaure, 2019), it's not "complete" (Martin-Martin et al., 2021). Thus, for the sake of being thorough, the search functions of some large publishers such as Taylor & Francis, Springer and Elsevier as well as websites such as Academia and ResearchGate were utilized. Initially, 124 unique publications were found with the possibility of being relevant to the research being conducted. After the first review of the work found, 25 of the initial 124 publications were discarded for being inaccessible. Upon closer inspection, 64 more of the publications were discarded for being from non-reputable sources, irrelevant, low quality or outdated. The remaining 35 publications were reviewed for their contents and found to be closely or tangentially related to the topic and scope of this dissertation.

The low amount of found relevant literature is interesting. An argument could be made that a combination of factors such as the widespread use of simulators in MET, an interest within the industry for employing competent officers & masters and legislative incentive should result in more interest in the topic. A number of reasons could be put forward to explain the lack of publications found. However, majority of these explanations would be speculative in nature, thus no discussions will be made on these. Any additional work with the aim of solidifying the reasons behind the apparent lack of interest in the topic was deemed to be out of scope. To the author's best abilities and knowledge, the review was reflective of the general interest in the topic.

One limiting factor of the review was the subject of the studies in question. Majority of the studies discarded that could be argued to be related to the topic of this research have chosen officers in training, or MET students, as their subjects. Some of these studies were kept due to relevant findings, some were kept as examples but most were discarded in order to limit to scope of the research as laid out in the title. To the author's best knowledge, only one prior work explore a similar concept to this study (Mazhari, 2018), which will be extensively reviewed later on.

With all that in mind, Table 1.1 displays overview of reviewed literature with their references, aims and methods in no particular order. Following, a more detailed overview of the literature is given.

Table 1.1: Overview of reviewed literature.

Reference	Aim	Method
Emad and Roth, 2008	Explore MET contradictions	Case study
Weintrit and Neumann, 2016	Explore a maritime training system	Case study
Elashkar, 2016	Review the importance of simulation in MET	Mixed methods
Cunha, 2019	Analyze navy officer’s proficiency	Statistical analysis
Kavanagh, 2006	Summarize research on ship simulation assessment	Case study
Lupu et al., 2016	Propose an assessment method	Statistical analysis
Baylon and Santos, 2011	Explore MET challenges	Literature review
Kobayashi, 2005	Propose a training method	Case study
Sellberg, 2017	Explore simulator use in MET	Literature review
Ghosh et al., 2014	Propose an assessment method	Literature review
Torre et al., 2019	Explore seafarer’s skills	Literature review
Fjeld et al., 2018	Explore bridge officer skills	Literature review
Mohovic et al., 2015	Identify knowledge gaps in COLREG	Questionnaire
Castells et al., 2016	Propose an assessment method	Mixed methods
Saeed et al., 2018	Propose an assessment method	Mixed methods
Kobayashi et al., 2004	Explore assessment techniques	Mixed methods
Zazeckis et al., 2009	Explore simulator capabilities for MET	Case study
Sellberg et al., 2018	Investigate simulator use in MET	Mixed methods
Belev and Daskalov, 2019	Summarize research on MET	Case study
Mazhari, 2018	Explore the knowledge and skill gap of officers	Mixed methods
Ernsten and Nazir, 2020	Propose an assessment method	Case study
Kartal et al., 2019	Identify officer qualifications	Mixed methods
Zhan, 2017	Propose an assessment method	Mixed methods
JIN-BIAO et al., 2015	Propose a training method	Mixed methods
Habberley, 1099	Propose an assessment method	Mixed methods
Fawcett, 2018	Present an assessment method	Case study
Sendi, 2015	Present a training method	Case study
Salman, 2013	Present a training method	Case study
Saarheim and Brown, 2016	Analyze a training method	Case study
Ghosh, 2017	Present an assessment method	Case study
Sampson et al., 2011	Analyze contemporary assessment methods	Mixed methods
Ghosh and Bowles, 2020	Analyze an assessment method	Survey
Manuel, 2017	Explore challenges in MET	Literature review
Godwin et al., 1959	Explore safety measures	Case study
Burger and Corbet, 1963	Present a training method	Mixed methods

Simulator use in MET goes far back, the earliest mention of the use of simulators in the context of maritime training comes in the form of specialized safety trainings for the operation of the nuclear powered vessel Savannah (Godwin et al., 1959). Mentions of a more generalized version of simulator training can be found as early as early 1960's, in the form of RADAR trainings (Burger and Corbet, 1963). It seems the use of simulators has been a hot topic for research ever since, with high volume of contemporary studies on the methods, effectiveness and efficiency of simulator training in MET. However, the literature shows there's still no unified method of simulator enhanced MET.

As seen in the table, a large number of works concern themselves with novel methods of maritime simulator training. Some are in the form of proposals (Kobayashi, 2015, JIN-BIAO et al., 2015, Saarheim and Brown, 2016) while others present a method that's already in use in certain institutions (Sendi, 2015, Salman, 2013, Zazeckis et al., 2009, Weintrit and Neumann, 2016). Although literature shows a wide variety of trainings methods as shown, there is a unified opinion on one topic. Studies on the topic agree that simulators are a highly beneficial tool when it comes to MET (Elashkar, 2016, Sellberg, 2017, Sellberg et al., 2018, Belev and Daskalov, 2019). More critical approaches to the general state of MET exist (Emad and Roth, 2008) yet simulator use is generally encouraged (Manuel, 2017, Baylon and Santos, 2011).

Use of simulators, however, seems to be even less unified of a topic than training. Literature can be found on proposals for assessment using simulators as early as late 1980's (Habberley, 1988). Much like training, the trend continues to contemporary work in the form of novel method proposals (Ghosh et al., 2014, Castells et al., 2016, Saeed et al., 2018, Zhang, 2017), analysis of contemporary methods (Kobayashi et al., 2004, Sampson et al., 2011), presenting novel methods already in use (Kavanagh, 2006, Lupu et al., 2016, Ernsten and Nazir, 2020, Ghosh, 2017, Ghosh and Bowles, 2020).

This might seem contradictory with the earlier statement of sparse literature, but as stated majority of these assessment methods are proposals, thus present no data in the form of assessment results over a large sample size. The remaining studies that are concerned with assessment methods overwhelmingly do not present assessment results to a degree which is large or useful enough to come to conclusions about the overall state of knowledge gaps in the industry (Cunha, 2019). Indeed, the research seems more concerned with the validity, or the comprehensiveness of the assessment methods themselves rather drawing conclusions about the industry from the work. However, work on bridge officer or master skillset and competency is not inexistent.

Torre et al., 2019 and Fjeld et al., 2018 set out to find out the necessary skills a seafarer shall possess for competency. Torre et al. set out to define the hard and soft skills of seafarers, and distributes them into "profiles" for each position aboard. Some common soft skills are found to be common among all profiles, namely, attention to detail, organizational skill, ability to work under pressure and teamwork. Fjeld et al. set out to identify the non-technical skills of specifically deck officers. Five skills are identified, these are situation awareness, managing workload, decision-making, leadership and communication. However, these studies do not conduct an analysis of the current workforce of the industry.

Focusing more on the prior mentioned subject, Kartal et al., 2019 aim to assess the qualifications of seafarers based on nationality with the help of expert opinions analyzed with the help of a fuzzy analytic hierarchy process. The results show that cost related factors play the biggest factor in industry decision-making, however performance, knowledge and awareness make up the majority of professional factors identified, which are the second largest factors in employment decisions. With this, it can be stated that an assessment of seafarer's performance, knowledge and awareness on certain topics, thus their knowledge gaps as a sum, is an important topic to tackle.

To this end, Mohovic et al., 2015 aim to find out about the knowledge gaps of seafarers in respect to COLREG. The study identifies COLREG Rule 6, Rule 8, Rule 9, Rule 13, Rule 18 and Rule 19 as rules commonly found to be hard to understand, thus creating a knowledge gap.

Finally, perhaps the most relevant work found, was Mazhari, 2018, which aims to explore the gap between expected skills of bridge officers and their practical applications. To this end, the study aims to find the gaps of knowledge and skill as perceived by employers and the officers themselves with the help of literature reviews, qualitative interviews and document analysis. The study finds gaps of knowledge in mainly in technical and practical knowledge, team-work and communication. These findings seem to fall in line with the hard and soft skills expected of seafarers mentioned before.

Another interesting finding of the study is the medium which the employers use in order to assess these knowledge gaps; mainly incident reports, revenue and expense analyses, performance analyses, audit reports and detention rates. Common denominator between these mediums is that they only allow the assessment of an employee after employment, this also explains the multitude of methods proposed in prior studies that would enable the assessment of skills of a potential employee.

However this works differs from the topic of this dissertation in that these knowledge gaps are those perceived by the employers and officers themselves. Indeed, with this dissertation the aim is to find knowledge gaps in the workforce by analyzing the actual abilities of masters and chief mates with master licenses, rather than their own perceptions. With this, a research gap is established, and our research question is finalized as "What are the knowledge gaps in master level BTRM among the world's fleet?"

2. METHODOLOGY

As discussed in the previous section, the current literature on the knowledge gaps on ship master level is lacking, thus relying on methods like literature review or analyzing existing data are not available as options. Data then, needs to be gathered first by us and then analyzed. Thus, for this work, the following four step research structure was decided on;

Firstly, through literature reviews, the principles of BTRM were distilled to their core elements. These key topics cover and include all aspects of BTRM while being kept to the smallest possible amount. This ensures that key topics which need more attention can be identified, and can be focused and expanded on if need be.

Secondly, using the above mentioned key topics, simulator scenarios were created. These scenarios were designed in such a way that each of them presents opportunities to evaluate as many of the above mentioned BTRM key topics as possible. In addition, these scenarios were diverse in the situations which they present, to ensure that the effects of different conditions on BTRM topics can be observed.

Thirdly, these scenarios were applied to ship masters, and during each application the participants were evaluated. For this, an evaluation method was decided on and criteria were determined.

Finally, the data gathered in the above process was analyzed by the means of statistical analysis. Figure 2.1 shows the research structure.

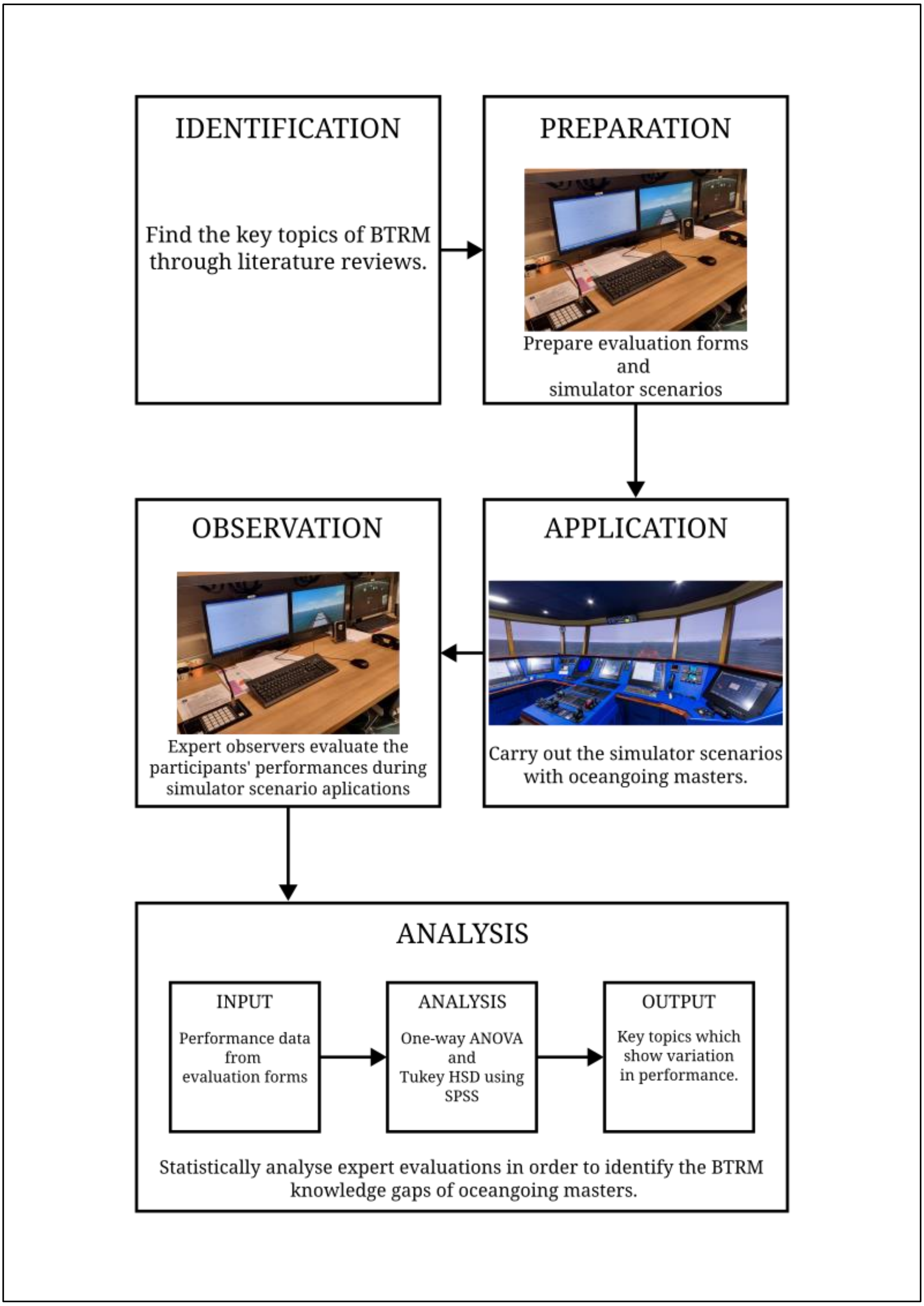


Figure 2.1: The research structure.

2.1. Simulator Applications

As discussed previously, to answer the research question data needs to be gathered. In order to gather data, simulator applications should be done. For this to be possible, simulator scenarios should be designed and finally, for this, BTRM key topics need to be determined in order to design the scenarios around.

2.1.1. BTRM Key Topics

In order to determine the key topics of BTRM, a literature review was conducted. Surprisingly, the amount of literature on the definition or topics of BTRM is little in amount. However, the existing literature is dense and comprehensive, and it seems most of the literature is based on a few works, which are considered "definitive".

Two such publications were mainly used in order to determine the core aspects of BTRM. These works are *"Bridge Team Management"* (Ross et al., 2017) and *"Ship Simulator and Bridge Teamwork"* more commonly known as *"IMO Model Course 1.22"* (Scariano and Davenport, 1987). Scanning through these publications reveal that a plethora of topics ranging from managing the briefing and the fatigue of the bridge personnel to ship's manoeuvring in current regimes. The definitions discussed later in this section are based off of these two works.

As discussed before, in order to bring these topics down to a manageable level and focus on these if need be, these topics need to be grouped into categories. By scanning the main topics discussed in *"Bridge Team Management"* and the curriculum of *"Ship Simulator and Bridge Teamwork"*, six core elements were determined, these are situational awareness, communication, proper use of navigational aids, collision prevention, emergency handling and ship handling. The rest of this section is dedicated to introducing and explaining each key topic.

Situational awareness, in maritime context, can be described as the knowledge of what exactly is happening on or around the ship. This includes the master's awareness of the state of the personnel, the position of any objects posing a threat to the ship's navigation, any restrictions on the navigation of the ship etc.

Communication is the sum of internal and external communications carried out by the master. This topic includes establishing channels of information, management of disputes, ensuring all communication is clear and understandable, proper briefing and debriefing of personnel, proper communication with external parties such as the vessel traffic services (VTS), the pilot or other vessels.

Proper use of navigational aids deals with the effective use of tools and devices found on the bridge. This includes the effective use of the RADAR, the electronic chart display (ECDIS), the global positioning system (GPS), magnetic and gyro compasses and other navigational aids, the knowledge of order of observatory priority and the knowledge of errors of navigational aids.

Collision prevention can be explained as the master's ability to avoid accidents by abiding by the rules of traffic at sea. This topic is mostly concerned with the knowledge and the application of International Regulations for Preventing Collisions at Sea (COLREG),

Emergency handling is the master's ability to handle and minimize damage during emergencies such as collision, grounding, fire onboard, man overboard or other emergencies. While this topic deals with the more general emergency handling concepts such as leadership, due to the diverse nature of emergencies it also deals with specifics of handling different types of situations as well.

Finally, ship handling is the master's ability to control and command the vessel. This is another diverse topic including such concepts as navigation under heavy currents, navigation under heavy winds, navigation in narrow channels and straits and knowledge of ship handling essentials. With all the pieces in place, we can now start designing the simulator scenarios, but before we get to that, we shall introduce the simulator system that will be used.

2.1.2. The Simulator System

For this research, a TRANSAS simulator system with 330° degrees of view was used. This simulator was chosen due to its small yet realistic layout. The smaller bridge allows the participants to be observed more keenly, and the realistic layout is intended to immerse them in the simulation. Figure 2.1 shows the simulator that was used.

Figure 2.2: The simulator system.

The simulator is donned with two multifunctional panels with ECDIS and RADAR functionality, one RADAR panel, one conning display, a gyro compass, a communications station, a multifunctional panel for GPS and automatic identification system (AIS), physical controllers for steering and engine, and information display panels for other navigational aids such as the echo sounder, speed log and autopilot. The simulator runs on Navi-Trainer Pro 5000 software. The scenarios were designed with the paired trainer software.

2.1.3. Designing the Simulator Scenarios

To test the BTRM competencies of the eventual participants, a total of six different simulation scenarios were designed. The scenarios were designed with the key points discussed earlier in mind, under different conditions. In this section, the scenarios are detailed. During the explanations, a term called “modifiers” will be used, and thus we shall start by first explaining this term and its implications.

2.1.3.1. Scenario Modifiers

Modifiers represent special conditions that can be met during navigation. They can be of any nature as long as they pose a threat to the safety of the navigation. A total of nine different modifiers were used in various combinations in the designed scenarios. These modifiers are as such:

1. **Restricted Visibility:** The inclusion of this modifier in a scenario means that during the scenario, a part or the whole of the navigation will be conducted within foggy areas, reducing visibility from the bridge.
2. **Nighttime:** The inclusion of this modifier in a scenario means that the navigation will be conducted during nighttime.
3. **GPS Malfunction:** The inclusion of this modifier in a scenario means that during the scenario, a part or the whole of navigation will be conducted without reliable GPS information.

4. **Engine Failure:** The inclusion of this modifier in a scenario means that at a pre-determined point in the scenario, an engine failure will be given.
5. **Rudder Failure:** The inclusion of this modifier in a scenario means that at a pre-determined point in the scenario, the participants will lose all control of the ship's rudder, including emergency steering.
6. **Quick Action Traffic:** The inclusion of this modifier in a scenario means that during the scenario, a part or the whole of navigation will be conducted among heavier than usual traffic, which requires quick action from the participant in order to safely clear.
7. **Slow Action Traffic:** The inclusion of this modifier in a scenario means that during the scenario, a part or the whole of navigation will be conducted among heavier than usual traffic, which gives the participant enough time to plan their actions beforehand.
8. **Fire Onboard:** The inclusion of this modifier in a scenario means that at a pre-determined point in the scenario, a fire will be started in the cargo office of the vessel.
9. **Man Overboard:** The inclusion of this modifier in a scenario means that at a pre-determined point in the scenario, a personnel will be seen to fall overboard from the forecastle of the vessel.

These modifiers were chosen in order to represent a wide array of situations that may affect the course of navigation. They can be broadly grouped into two categories, modifiers which require a change of navigational techniques and modifiers which require immediate action.

Restricted visibility, nighttime, GPS malfunction and slow action traffic are modifiers which require a change of navigational techniques. These modifiers may require the change of observation method such as restricted visibility denying the use of eyesight, or GPS malfunction limiting the use of ECDIS. They may also require deviating from the route plan, such as heavy traffic conditions which may require drastic course alterations. These modifiers are chosen to better observe the competencies of the participants in the key topics of situational awareness, proper use of navigational aids, collision prevention and ship handling, although they can also be used to measure the competencies in other key points depending on how they're applied in a given scenario.

Quick action traffic, engine failure, rudder failure, fire onboard and man overboard are modifiers which require immediate action. Although under certain navigational tasks engine and rudder failures may not cause an immediate threat to the safety of navigation, the designed scenarios ensure that they do. These modifiers create emergency conditions in which the participants will need to utilize their communication and emergency handling skills to the fullest. Quick action traffic, engine failure and rudder failure modifiers are also used to measure the competencies in ship handling. As before, these modifiers can also be used to measure the competencies in other key points depending on how they're applied in a given scenario.

With the modifiers explained, we can now move on to the design of the scenarios themselves. A total of six different scenarios in six different geographical areas were designed. In the following sub-sections, these will be detailed in no particular order.

2.1.3.2. Istanbul Strait

This scenario takes places within the Istanbul Strait. The participants are tasked with following a pre-made, southbound route plan. Contrary to the current application, two-way traffic is applied within the strait and as such the participants must follow the southbound traffic separation lane. Along the strait, the common currents of the area are inputted in the system averaging 2 to 3 knots of currents following the curvature of the strait southbound. Northbound traffic is present in the scenario, while the participants man the only vessel proceeding southbound.

Modifiers applied in this scenario are restricted visibility, GPS malfunction and engine failure, the application of these modifiers will be detailed further on. Figure 2.2 shows the scenario layout which displays the geographical area, with the pre-made route plan shown and certain checkpoints labeled.

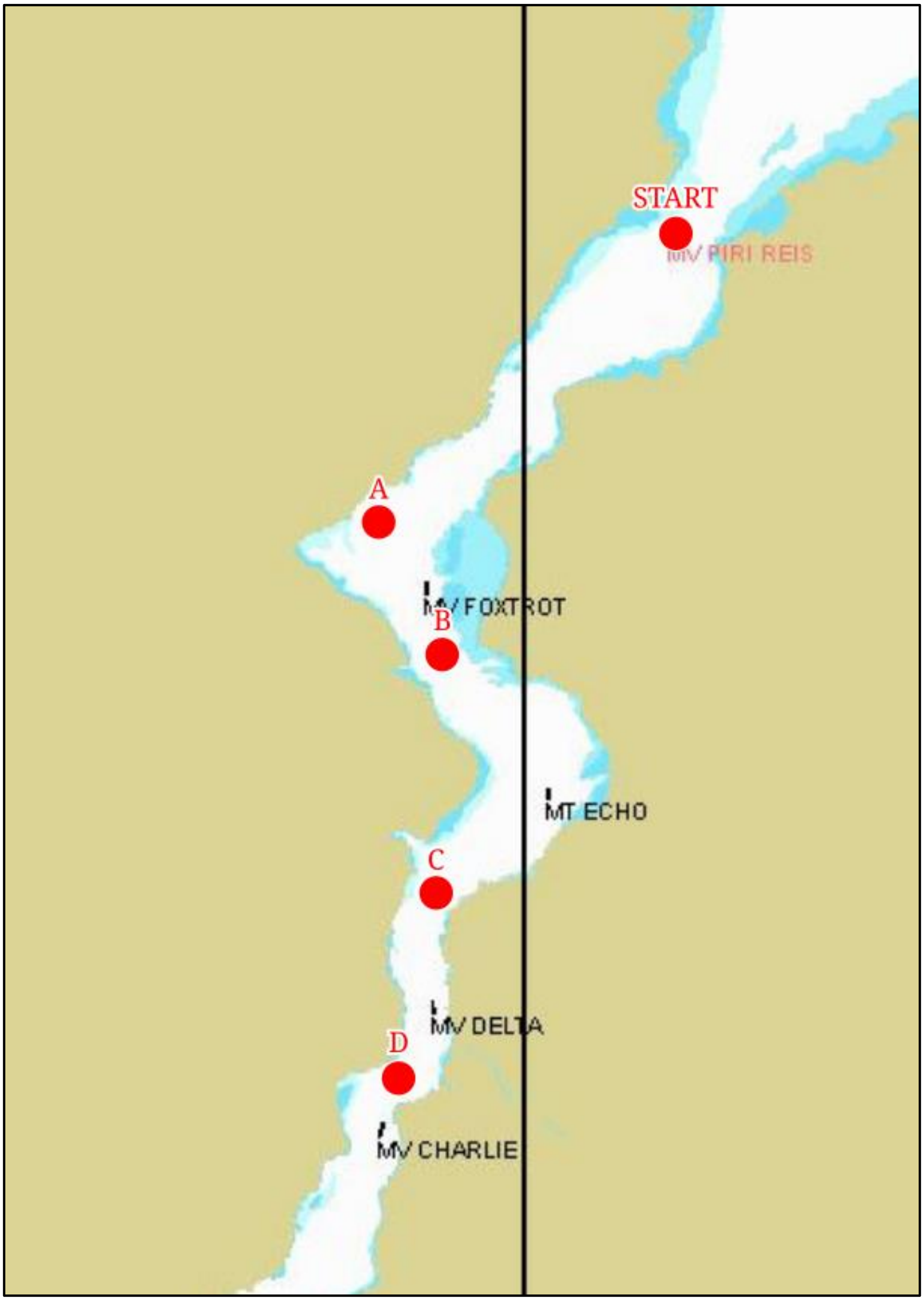


Figure 2.3: The Istanbul Strait scenario layout.

A sequential list of the events that take place during the application this scenario are as such; Firstly, at the start of the scenario, an announcement is made that restricted visibility conditions are present within the strait by the VTS. The expected action by the participant immediately after the announcement is to brief their bridge team of their plans regarding navigating under restricted visibility.

Following the announcement the visibility will be slowly reduced to 250 meters over 5 minutes. The expected action by the participant is to take precautionary actions other than those mandatory, such as reducing speed to the minimum safe speed dictated by the VTS, assigning extra lookouts, and heavier utilization of navigational aids such as the ECDIS and the RADAR.

At checkpoint A, another announcement is made by the VTS that due to military exercises, GPS signals may be lost between checkpoints B and C. The expected action by the participant immediately after the announcement is another briefing regarding their plans for navigating without reliable GPS signal.

At checkpoint B, the GPS signal of the vessel is frozen. This is done in a way that the malfunction does not generate alarms, as the GPS is still receiving signals albeit faulty ones. The expectation is for the participant, having being told the exact point which there could be a GPS signal loss, to notice the change and take appropriate precautionary action. In this case, the primary observation method should be switched to the RADAR, primary speed observation method should be switched to the speed log and alternative positioning methods should be applied on the ECDIS.

At checkpoint C, the GPS signal and visibility are both restored. The expected action is to revert back to standard navigational techniques and lift the precautionary actions.

At checkpoint D, an engine failure is given. The expected action is to communicate with the VTS, as well as the engine department and carry out emergency anchoring, handling the emergency situation without grounding.

The Istanbul Strait scenario is designed to be very demanding. As such, this scenario contains more modifiers than the rest, and in a more tightly packed fashion. The geographical area is intentionally chosen to be a hard area to navigate without pilotage, with tight turns and heavy currents. The intention behind this is the see the effects of the difficulty of navigation on the performance of the participants.

2.1.3.3. Rotterdam Approach

This scenario takes places on the coast of Netherlands. The participants are tasked with following a pre-made route plan approaching Rotterdam. No significant wind or currents are applied in this scenario. The participants man a vessel following an eastbound traffic separation lane, with other vessels present within the lane. At the starting position, there's a vessel to the participant's stern and one to their port side that follows with the same speed as the initial speed of the participants. There's another vessel to their starboard side that is following the separation lane, with speed greater than that of the participants' vessel. Finally, two vessels to the participants' starboard bow are crossing the lane, with speed and distance that create a collision risk with the participants.

Modifiers applied in this scenario are quick action traffic and man overboard, the application of these modifiers will be detailed further on. Figure 2.3 shows the scenario layout which displays the geographical area, with the pre-made route plan shown and certain vessels labeled.

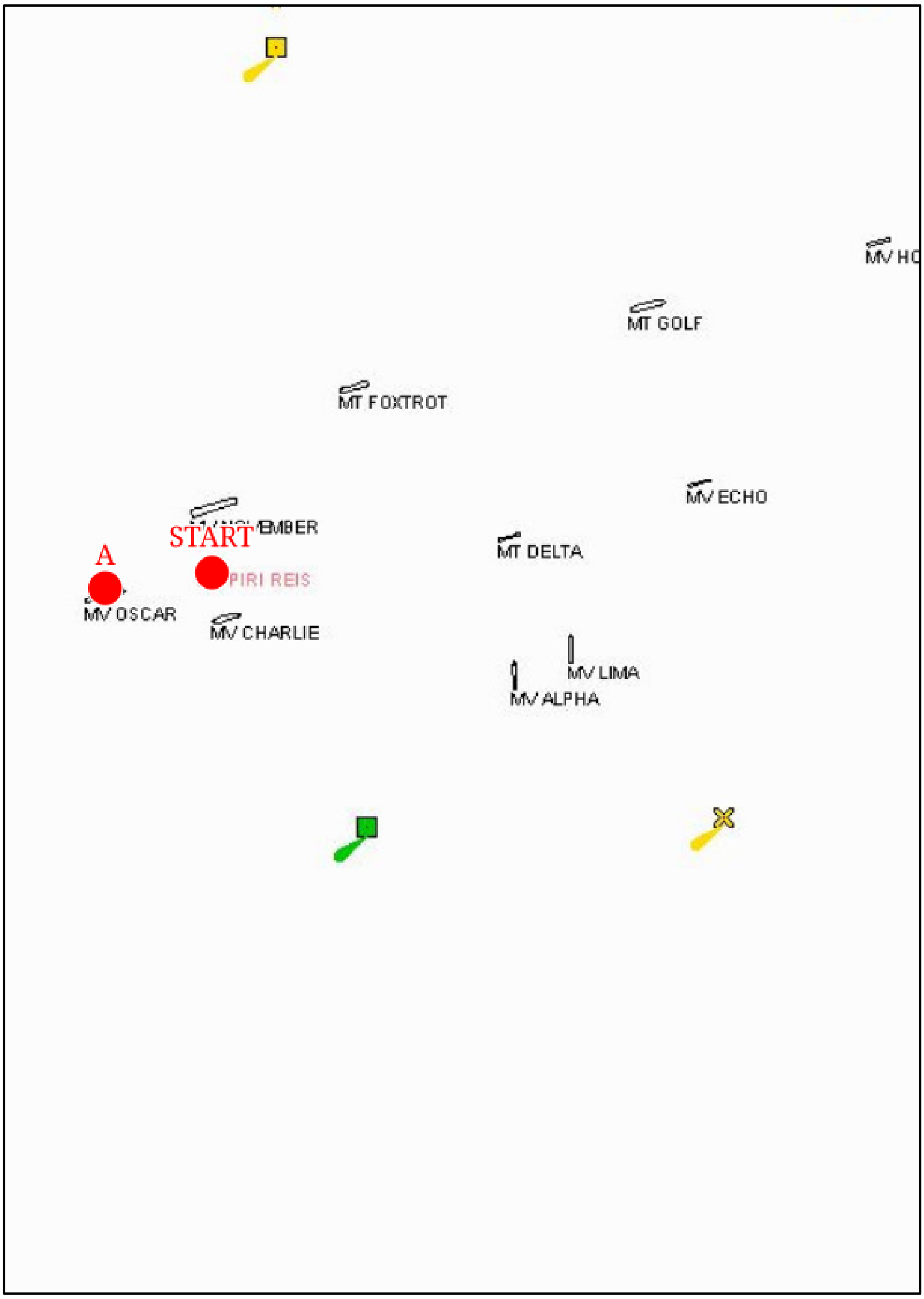


Figure 2.4: The Rotterdam approach scenario layout.

As seen in the layout, the initial position of the vessel is tightly packed. The expectation is for the participant to clear the traffic in a safe manner. This could be achieved in a number of ways, most of which require a reduction in speed. If done, the expectation is to communicate with the vessel A in order to let her know of their intention.

After the traffic is cleared, when all vessels cease to pose a threat to the navigation at hand, a man overboard situation is created. The expectation is to immediately take appropriate action such as starting the man overboard manoeuvre, sounding the general alarm, coordinating crew for picking up personnel and sending a distress message. All of this are expected to be done in a timely fashion, and in the correct order.

This scenario, environmentally has ideal conditions, however the traffic and emergency situations require quick and effective decision making, effective communication and ship handling skills.

2.1.3.4. Messina Strait

This scenario takes places within the Messina Strait. The participants are tasked with following a pre-made, northbound route plan starting on the coast of Regio Calabria. Currents averaging 1-2 knots are inputted following the natural curve of the strait southbound.

Modifiers applied in this scenario are slow action traffic and nighttime, the application of these modifiers will be detailed further on. Figure 2.4 shows the scenario layout which displays the geographical area, with the pre-made route plan shown and a checkpoint labeled.

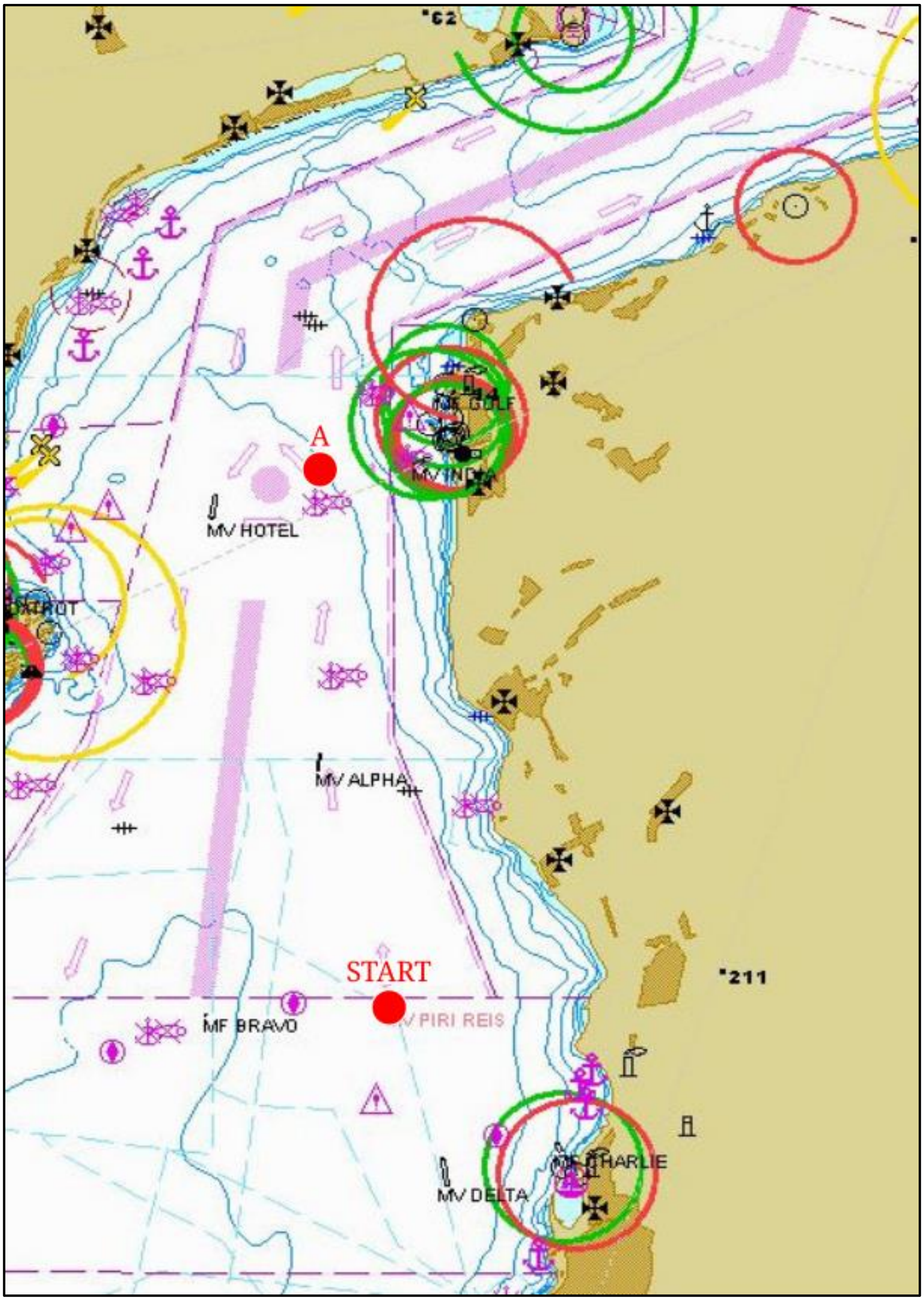


Figure 2.5: The Messina Strait scenario layout.

Firstly, due to the nighttime modifier, it's expected from the participant to increase the priority of RADAR for observation.

As seen in the figure, at the initial position there is a vessel to the participants' port side which is crossing the separation lane. Another vessel is present to their starboard quarter, which is overtaking the participants' vessel. More traffic can be seen on the starboard side as well. The expectation is to clear the initial traffic by altering course to port.

Heavy crossing ferry traffic is present at checkpoint A, with one ferry purposefully being sent out from port at a time and with speed to ensure a collision course with the participants. Note that the ferry is controlled by the instructor, and a collision is always avoided without making unrealistic and unpredictable movements as the ferry. The expected action is to notice the ferry boat in time, and take appropriate actions to give more time to self to act and avoid a collision such as reducing speed and altering course.

2.1.3.5. Singapore Strait

This scenario takes places within the Singapore Strait. The participants are tasked with following a pre-made, eastbound route plan approaching anchorage on the coast of Singapore. No significant wind or currents are inputted to the system.

Modifiers applied in this scenario are slow action traffic and rudder failure, the application of these modifiers will be detailed further on. Figure 2.5 shows the scenario layout which displays the geographical area, with the pre-made route plan shown and certain checkpoints labeled.

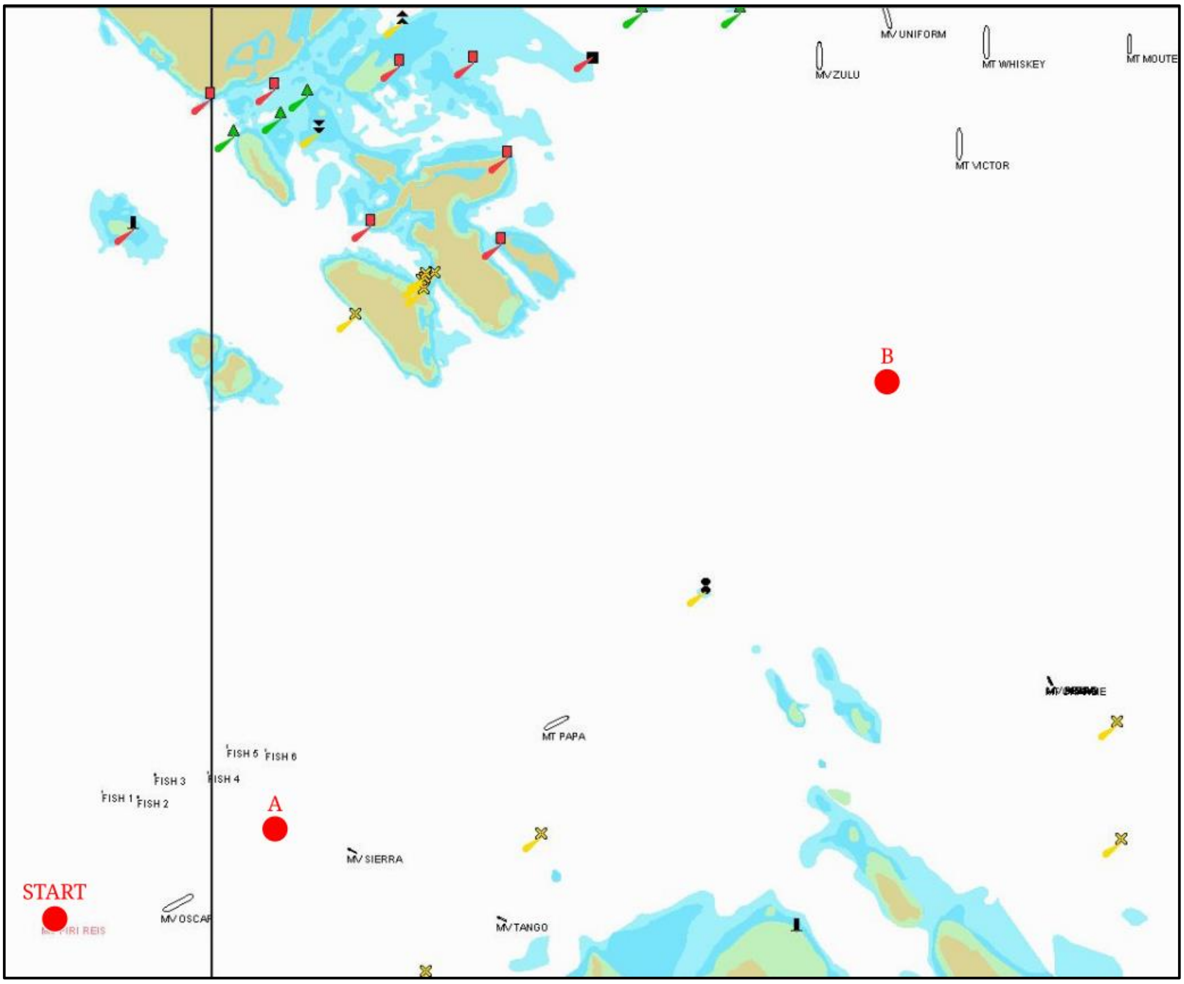


Figure 2.6: The Singapore Strait scenario layout.

Firstly, the starting position has vessels crossing the separation lane and fishing boats engaged in fishing within the separation. Another vessel following the separation lane is present as well. The expectation is to clear this initial traffic without having any near misses or collision risk.

At checkpoint A, the participants are contacted by the VTS in order to let them know of their anchorage position. This is intentionally done here, as the expectation is for the participant to not get distracted and be able to handle both the communication and the navigation around the fishing boats.

At checkpoint B, a lot of crossing vessels, both north and southbound, are present. Many vessels following the westbound traffic separation lane are also present. This is also where the participants need to start crossing the traffic separation in order to reach their anchorage position. The expectation is to start a their turn in order to cross after they have cleared the north and southbound crossing vessel.

When the participants start their swing, a rudder failure is created in the form of a rudder jam. The rudder is locked to the port command (as ensured by the swing direction) which was given and due to the nature of a rudder jam, emergency steering ceases being an option as well. The expectation is to be able to slow down the vessel and carry out emergency anchoring, as well as communicating with the surrounding vessels and/or the VTS in order to request wide berth. Internal communication between the bridge team and the engine department is also expected.

2.1.3.6. Dover Strait

This scenario takes places within the Dover Strait. The participants are tasked with following a pre-made, westbound route plan. No significant wind or currents are inputted to the system.

Modifiers applied in this scenario are restricted visibility and fire onboard, the application of these modifiers will be detailed further on. Figure 2.6 shows the scenario layout which displays the geographical area, with the pre-made route plan shown and two checkpoints labeled.

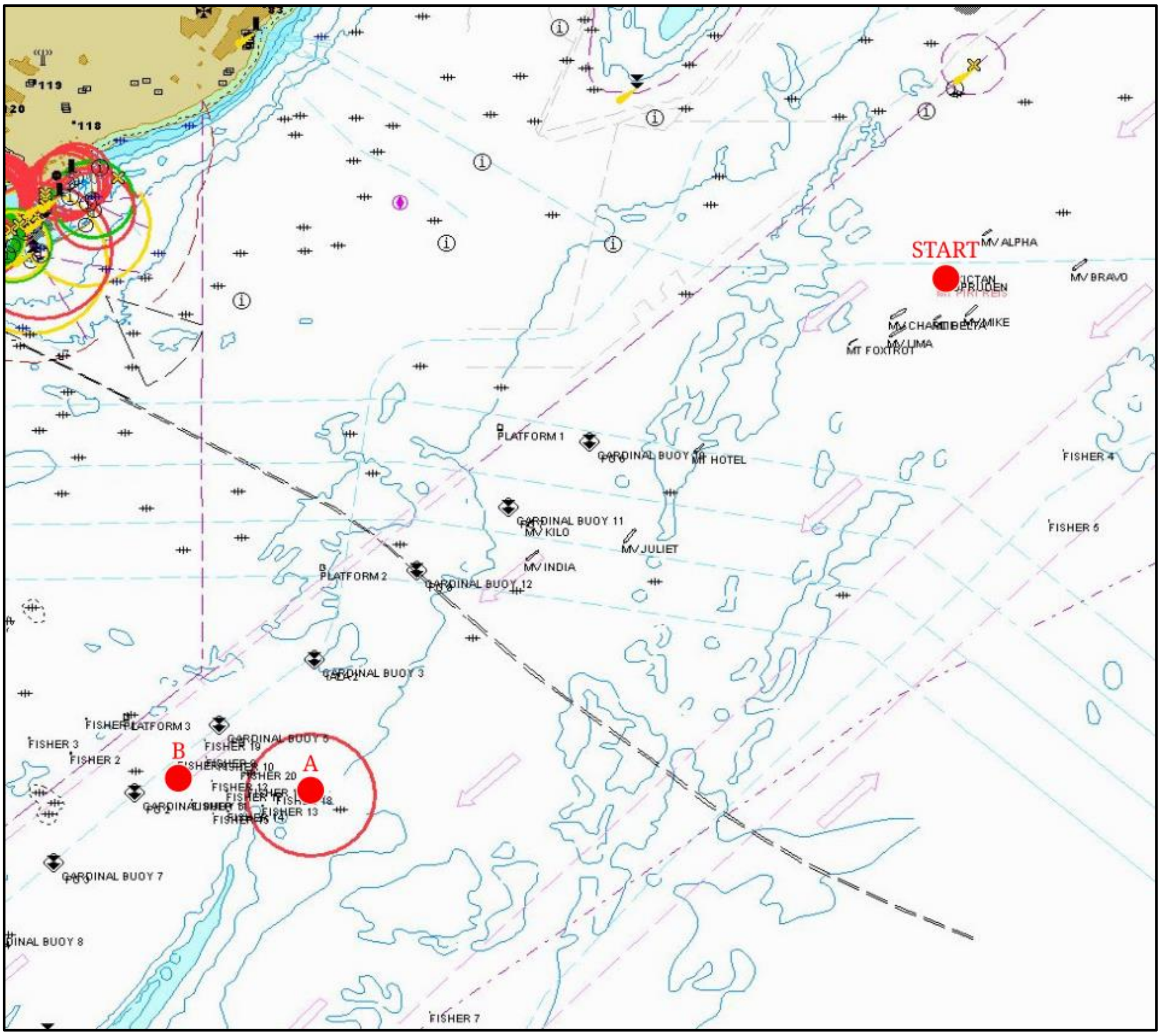


Figure 2.7: The Dover Strait scenario layout.

The restricted visibility modifier is applied from the start of the scenario. The expected actions are briefing the team for navigation under restricted visibility, assigning extra lookouts, and heavier utilization of navigational aids such as the ECDIS and the RADAR.

At checkpoint B, a high number of fishing boats can be seen, with the number and the placement of the vessels following the separation lane this situation creates a navigational risk. The expected action is to deviate from the pre-made course and alter to port, proceeding south of the lighthouse at checkpoint A.

However should the participants choose to proceed, after checkpoint A is passed, a fire onboard situation is created. The expected action is take immediate action, confirming the fire, sounding the general alarm, coordinating the muster effort and the fire teams.

This scenario has a long period of standard navigation, with as little stimulants as possible for as long as possible between the start of the scenario at which the participants are expected to get used to the restricted visibility conditions and the emergency situation. The restricted visibility modifier is also chosen in order to slow the participants down, ensuring a longer navigation. This is done in order to observe the effects of fatigue and minimal stimulation on the participants' performance.

2.1.3.7. Tanger-Med Approach

This scenario takes places within the Gibraltar Strait. The participants are tasked with following a pre-made route plan approaching the port of Tanger-Med. A current of 2 knots is inputted in the system towards 067°.

Modifiers applied in this scenario are quick action traffic, slow action traffic and man overboard, the application of these modifiers will be detailed further on. Figure 2.7 shows the scenario layout which displays the geographical area, with the pre-made route plan shown and two checkpoints labeled.

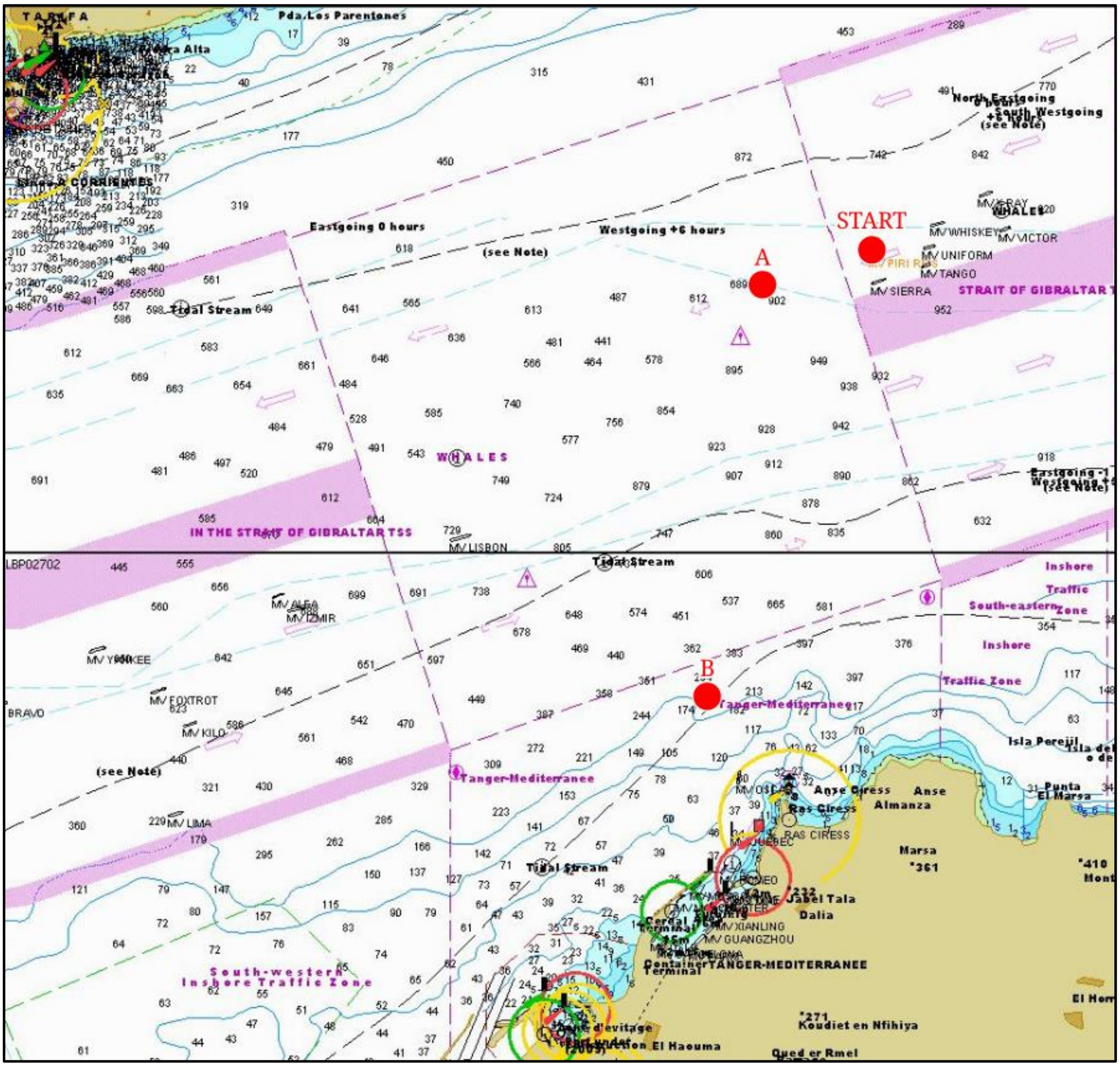


Figure 2.8: The Tanger-Med approach scenario layout.

The initial position of the vessel is tightly packed with vessels following the same westbound separation lane, some overtaking the participants. The expectation here is to slow the vessel down in order to clear this traffic. The participants are expected to be in the vicinity of checkpoint A when they start their swing in order to cross southbound.

From the start of the scenario, until checkpoint A is cleared, the participants are constantly contacted by the pilot, with the intention of hurrying them. The expectations is for the participants to keep the communication channel with pilotage open, but still keep a safe navigation speed.

Due to the large number of vessels proceeding eastbound, the cross is difficult. The expectation is for the participant to be able to plan and execute the cross in a safe and timely manner, and for them to brief the bridge team of their intentions.

At checkpoint B, a man overboard situation is created. The expectation is to immediately take appropriate action such as starting the man overboard manoeuvre, sounding the general alarm, coordinating crew for picking up personnel and sending a distress message. All of this are expected to be done in a timely fashion, and in the correct order.

This scenario presents two of the same modifiers as the Rotterdam approach scenario, however they are dealt in different manners. The Rotterdam approach scenario, as discussed before, requires quick thinking when it comes to handling the heavy traffic. This scenario, while initially requires quick thinking, has only one safe option thus it’s possible to reach a conclusion faster. In addition, the heavy traffic after checkpoint A requires careful planning and manoeuvring rather than quick thinking.

2.1.3.8. General Information About The Scenarios

All scenarios were designed in order to be able to assess all determined key points. For consistency, all scenarios were done using the same vessel model. Information about this vessel model is presented in table 2.1 and figure 2.8, and figure 2.9. Table 2.1 displays an overview of the ship model. Figure 2.8 shows the model’s wheelhouse poster. Figure 2.9 shows the model’s pilot card.

Table 2.1: Overview of the ship model.

Model Name: Bulk Carrier 1			
View		**General Information**	
		Type:	Bulk Carrier
		Displacement (t):	23565
		Maximum Speed (kts):	15
Propulsion		**Dimensions**	
Engine:	Slow Speed Diesel (8827 kW)	Length (m):	182.9
Propeller:	Fixed Pitch Propeller	Breadth (m):	22.6
Thrusters (Bow / Stern):	None	Draft (m):	7.6

WHEELHOUSE POSTER

Ship's name Bulk carrier 1 (Dis.23565t) bl. TRANSAS 2.31.32.0 , Call sign N/A ,
Gross tonnage N/A , Net tonnage N/A , Load Condition Ballast , Displacement 23565 tons , Deadweight N/A tons

DRAFTS IN PRESENT CONDITION	
Forward	7.5 m
Forward extreme	7.5 m
After	7.6 m
After extreme	7.6 m

STEERING PARTICULARS	
Type of rudder	Normal balance rudder
Maximum rudder angle	35 degrees
Hard-over to hard-over(1/2 pumps)	34 sec/17 sec
Neutral effect angle	1.26 degrees
Flanking Rudders	0

ANCHORS INFO	
Anchor(s) (No./types)	2 (PortBow / StbdBow)
No. of shackles	15 / 15
Max. rate of heaving, m/min	9 / 9
(1 shackle =25 m / 13.7 fathoms)	

PROPULSION PARTICULARS			
Type of Main Engine	Low speed diesel	Number of propellers	1
No. of Main Engines	1	Propeller rotation	Right
Max. power per shaft	1 x 8827 kW	Propeller type	FPP
Astern power	60 % ahead	Min. RPM	24
Time limit astern	N/A	Emergency FAH to FAS	1.1 seconds

Engine Telegraph Table

Engine Order	Speed, knots	Engine power, kW	RPM	Pitch ratio
"FSAH"	15	8567	114.3	0.71
"FAH"	11.2	3640	85.3	0.71
"HAH"	7.2	975	54.9	0.71
"SAH"	5.9	548	44.9	0.71
"DSAH"	4	180	30.6	0.71
"DSAS"	-1.7	289	-31.5	0.71
"SAS"	-2.2	771	-45.1	0.71
"HAS"	-2.8	1440	-55.1	0.71
"FAS"	-4.5	4968	-84.8	0.71

THRUSTER EFFECT

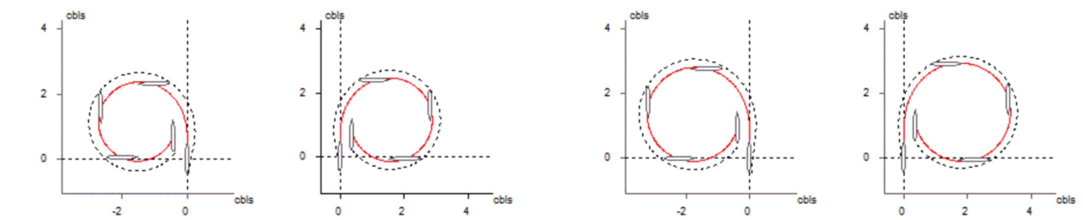
Thruster (s)	No. of units	Power (kW)	Time delay for full thrust(s)	Turning rate at zero speed(degrees/min)	Time delay to reverse full thrust(s)	Not effective above speed (knots)
Bow	N/A					
Stern	N/A					
Combined	N/A					

Auxiliary Steering Device(s): N/A

DRAFT INCREASE IN PRESENT CONDITION

	Squat effect			Heel effect	
Under keel clearance	Ship's speed	Bow squat	Stern squat	Heel angle	Draft increase
3m	14.04 knots	0.89 m	1.23 m	2 deg	0.34 m
	11 knots	0.74 m	0.57 m	4 deg	0.65 m
	7.18 knots	0.26 m	0.28 m	8 deg	1.25 m
2 m	13.79 knots	0.62 m	1.44 m	12 deg	1.8 m
	10.97 knots	0.91 m	0.68 m	16 deg	2.29 m

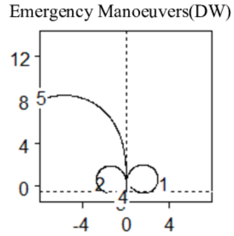
Deep Water TURNING CIRCLES Shallow Water*



Eng.	Rudd.	Advance	Transfer	Tact. D	Final RoT	Final speed	Final time
100	35	2.4 cbls	1.08 cbls	2.81 cbls	59 deg/min	8 knots	359.6 s
100	-35	2.3 cbls	-1.02 cbls	-2.65 cbls	-60 deg/min	8 knots	348.6 s

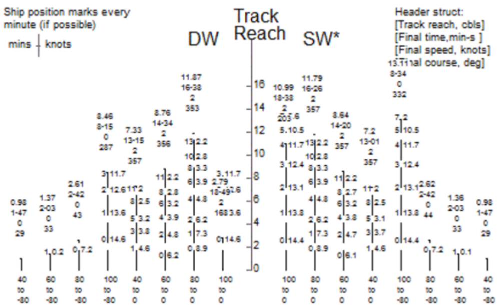
Eng.	Rudd.	Advance	Transfer	Tact. D	Final RoT	Final speed	Final time
100	35	2.9 cbls	1.39 cbls	3.29 cbls	54 deg/min	9 knots	400.6 s
100	-35	2.77 cbls	-1.32 cbls	-3.15 cbls	-55 deg/min	8 knots	389.6 s

Emergency Manoeuvers(DW)

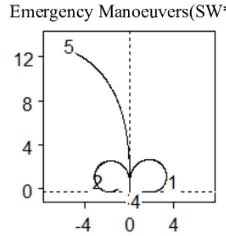


No.	Rudd.	Eng.	Full_time	Head_reach	Side_reach
1	35	100	176.4 s	1.59 cbls	2.81 cbls
2	-35	100	169.8 s	1.57 cbls	-2.65 cbls
3	35	-80	359.6 s	-0.2 cbls	-1.65 cbls
4	-35	-80	423.6 s	0.4 cbls	0.34 cbls
5	0	-80	495.6 s	8.46 cbls	-8.07 cbls

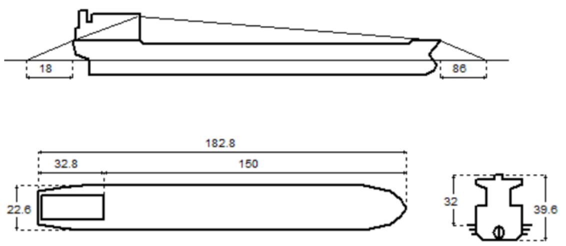
STOPPING CHARACTERISTICS



Emergency Manoeuvers(SW*)



No.	Rudd.	Eng.	Full_time	Head_reach	Side_reach
1	35	100	201.7 s	1.8 cbls	3.29 cbls
2	-35	100	195.1 s	1.74 cbls	-3.15 cbls
3	35	-80	436.6 s	0.25 cbls	-0.99 cbls
4	-35	-80	421.6 s	0.01 cbls	1.2 cbls
5	0	-80	515.6 s	13.1 cbls	-5.79 cbls



MAN OVERBOARD
RESCUE MANOEUVRE

SEQUENCE OF ACTION TO BE TAKEN:

- TO CAST A BUOY
- TO GIVE THE HELM ORDER
- TO SOUND THE ALARM
- TO KEEP THE LOOK OUT

Approximate Maneuver Program

Time	Action
0 s	Set rudder 35 STBD. Wait till ship course altered to 51.5 degrees from initial.
50 s	Set rudder 35 PORT. Wait till course altered to -170 degrees from initial.
287 s	Turn AP on. The difference between AP course and initial course must be 180 degrees.

Bridge To Stern(A)	32.88 m	Length of Midbody(D)	137.16 m	Air Draft(G)	32 m / 105 ft 3 in
Bridge To Bow(B)	150 m	Length Overall(E)	182.88 m	Forward Blind Zone(I)	86 m
Breadth(C)	22.63 m	Height(F)	39.55 m	Backward Blind Zone(J)	18 m

* Shallow Water: depth is equal 2 Draft ** Model: 2.166.1432.129; VSY02: 2.91.3084.0;

PERFORMANCE MAY DIFFER FROM THIS RECORD DUE TO ENVIRONMENT, HULL AND LOADING CONDITION

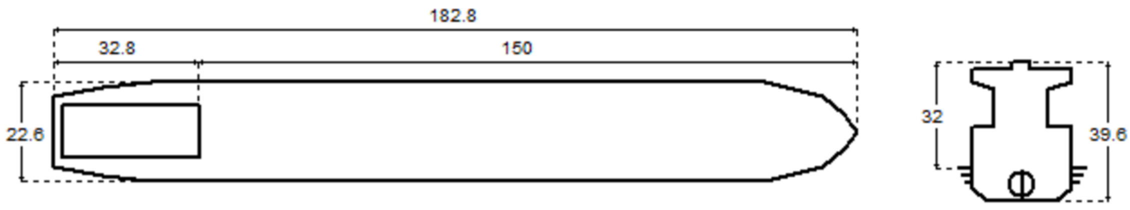
Figure 2.9: The wheelhouse poster of the model ship.

PILOT CARD

Ship name	Bulk carrier 1 (Dis.23565t) bl. TRANSAS 2.31.32.0 *			Date	26.01.2016
IMO Number	N/A	Call Sign	N/A	Year built	1976
Load Condition	Ballast				
Displacement	23565 tons		Draft forward	7.5 m / 24 ft 8 in	
Deadweight	N/A tons		Draft forward extreme	7.5 m / 24 ft 8 in	
Capacity			Draft after	7.6 m / 24 ft 12 in	
Air draft	32 m / 105 ft 3 in		Draft after extreme	7.6 m / 24 ft 12 in	

Ship's Particulars

Length overall	182.88 m	Type of bow	Bulbous
Breadth	22.63 m	Type of stern	V-shaped
Anchor(s) (No./types)	2 (PortBow / StbdBow)		
No. of shackles	15 / 15		(1 shackle =25 m / 13.7 fathoms)
Max. rate of heaving, m/min	9 / 9		



Steering characteristics

Steering device(s) (type/No.)	Normal balance rudder / 1	Number of bow thrusters	N/A
Maximum angle	35	Power	N/A
Rudder angle for neutral effect	1.26 degrees	Number of stern thrusters	N/A
Hard over to over(2 pumps)	17 seconds	Power	N/A
Flanking Rudder(s)	0	Auxiliary Steering Device(s)	N/A

Stopping

Description	Full Time	Head reach
FAH to FAS	163.2 s	2.61 cbls
HAH to HAS	254.5 s	2.38 cbls
SAH to SAS	314.6 s	2.37 cbls

Turning circle

Ordered Engine: 100%, Ordered rudder: 35 degrees	
Advance	2.4 cbls
Transfer	1.08 cbls
Tactical diameter	2.81 cbls

Main Engine(s)

Type of Main Engine	Low speed diesel	Number of propellers	1
Number of Main Engine(s)	1	Propeller rotation	Right
Maximum power per shaft	1 x 8827 kW	Propeller type	FPP
Astern power	60 % ahead	Min. RPM	24
Time limit astern	N/A	Emergency FAH to FAS	1.1 seconds

Engine Telegraph Table

Engine Order	Speed, knots	Engine power, kW	RPM	Pitch ratio
"FSAH"	15	8567	114.3	0.71
"FAH"	11.2	3640	85.3	0.71
"HAH"	7.2	975	54.9	0.71
"SAH"	5.9	548	44.9	0.71
"DSAH"	4	180	30.6	0.71
"DSAS"	-1.7	289	-31.5	0.71
"SAS"	-2.2	771	-45.1	0.71
"HAS"	-2.8	1440	-55.1	0.71
"FAS"	-4.5	4968	-84.8	0.71

Figure 2.10: The pilot card of the model ship.

2.2. The Evaluation Process

In this section, the evaluation process for the simulator applications is described. Evaluations are carried out by observers. Three observers have participated in the research. The observers were chosen due to their experience in the field. All observers are oceangoing masters. Information about the observers are given in table 2.2.

Table 2.2: Observer education level and sea service.

Number	Education Level	Sea Service
1	Bachelor's degree	37 years
2	Bachelor's degree	40 years
3	Master's degree	22 years

The observers were asked to observe the participants during the scenario applications from the simulator control room. The observers were able to see and hear the bridge, able to see the ECDIS and RADAR screens, and several aerial views of the ship and the area. The participants also had access to information such as the speed of the vessel. The observers were then asked to score the participants at the end of each scenario. The scoring was done for each key topic identified, the three observers were asked to decide on the final score for each topic together after discussion, instead of scoring individually. For each scenario, the observers were also told the expectations from the participant, and were given a set of criteria for scoring.

Scoring was done out of 10, with each point increase representing an increase in meeting the expectations in any given topic. It also aims to reflect the severity of any shortcomings, if any. The scoring criteria is shown in table 2.3. The evaluation form used is given in Appendix A.

Table 2.3: Scoring criteria by point.

Score	Criteria
1	The participant cannot meet any expectations. They endanger the safety of the ship and the personnel.
2	The participant cannot meet any expectations. They have no knowledge on this topic.
3	The participant cannot meet any expectations. Their knowledge of this topic is limited.
4	The participant cannot meet most expectations. They have critical gaps in knowledge.
5	The participant meets some expectations. They have critical gaps in knowledge.
6	The participant meets most expectations, shows average performance.
7	The participant meets most expectations. They have minor gaps in knowledge.
8	The participant meets all expectations, but has small problems in doing so.
9	The participant meets all expectations, and has no problems in doing so.
10	The participant shows performance above expectation.

2.3. Participants and Simulator Applications

A total of 172 simulator applications were done with 103 participants. All of the participants were oceangoing masters. The scenarios were randomly chosen for each participant, and with each participant up to 3 scenarios were done as time allowed. Table 2.4 displays the final distribution of the number of applications per scenario.

Table 2.4: Number of applications per scenario.

Scenario	Number of Applications
Istanbul Strait	46
Rotterdam Approach	29
Messina Strait	33
Singapore Strait	19
Dover Strait	13
Tanger-Med Approach	33

3. ANALYSIS AND RESULTS

After the applications and the evaluations, it is now time to analyze the data gathered. For this, the statistical analysis method of one way analysis of variance (ANOVA) was chosen. The reason for this choice of method is as such; the study has one independent variable in the form of the scenarios carried out by each participant, and multiple dependent variables in the form of evaluation scores for each category. With repeated tests of ANOVA, we can determine the level of variance of each topic between groups, or in this case, scenarios. To summarize, this method allows us to see in which scenarios a greater level of variance was observed and in which BTRM key topics. The analysis was done using Statistical Product and Service Solutions (SPSS) software. Before moving on to the one way ANOVA analysis, table 3.1 shows the descriptive statistics results in order to present the data gathered. Due to size restrictions, scenario names will be shortened to their first word in the table.

Table 3.1: Descriptive Statistics of the Data Gathered.

						95% Confidence Interval for Mean			
		N	**Mean**	**Std. Deviation**	**Std. Error**	**Lower Bound**	**Upper Bound**	**Min.**	**Max.**
Situational Awareness	**Istanbul**	13	6.23	1.166	.323	5.53	6.94	5	9
	Rotterdam	46	6.48	1.243	.183	6.11	6.85	4	9
	Messina	29	5.93	1.223	.227	5.47	6.40	3	9
	Singapore	33	5.94	1.059	.184	5.56	6.31	3	8
	Dover	19	6.00	1.374	.315	5.34	6.66	3	9
	Tanger-Med	33	6.64	1.295	.225	6.18	7.10	5	9
	Total	173	6.24	1.243	.095	6.06	6.43	3	9
Communication	**Istanbul**	13	6.38	1.121	.311	5.71	7.06	5	9
	Rotterdam	46	6.85	1.154	.170	6.51	7.19	4	9
	Messina	29	6.03	1.085	.201	5.62	6.45	4	9
	Singapore	33	6.09	1.100	.192	5.70	6.48	4	8
	Dover	19	6.05	1.026	.235	5.56	6.55	4	8

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min.	Max.
						Lower Bound	Upper Bound		
Communication	**Tanger-Med**	33	6.52	1.326	.231	6.05	6.99	4	9
	Total	173	6.38	1.183	.090	6.20	6.56	4	9
Proper Use of Navigational Aids	**Istanbul**	13	6.08	1.115	.309	5.40	6.75	4	9
	Rotterdam	46	6.43	1.311	.193	6.05	6.82	4	10
	Messina	29	5.79	1.146	.213	5.36	6.23	3	9
	Singapore	33	5.82	1.044	.182	5.45	6.19	3	8
	Dover	19	6.05	1.471	.337	5.34	6.76	3	9
	Tanger-Med	33	6.33	1.339	.233	5.86	6.81	4	10
	Total	173	6.12	1.259	.096	5.93	6.31	3	10
Collision Prevention	**Istanbul**	13	6.31	.855	.237	5.79	6.82	5	8
	Rotterdam	46	6.72	.886	.131	6.45	6.98	5	9
	Messina	29	6.03	1.052	.195	5.63	6.43	3	9
	Singapore	33	6.06	.899	.157	5.74	6.38	3	8
	Dover	19	5.95	1.079	.247	5.43	6.47	4	9
	Tanger-Med	33	6.52	1.176	.205	6.10	6.93	5	9
	Total	173	6.32	1.028	.078	6.17	6.48	3	9
Emergency Handling	**Istanbul**	13	5.92	.954	.265	5.35	6.50	4	7
	Rotterdam	46	6.50	1.278	.188	6.12	6.88	2	9
	Messina	29	5.62	1.147	.213	5.18	6.06	3	7
	Singapore	33	6.03	1.185	.206	5.61	6.45	2	9
	Dover	19	5.63	1.257	.288	5.03	6.24	3	7
	Tanger-Med	33	6.33	.957	.167	5.99	6.67	5	9
	Total	173	6.09	1.192	.091	5.91	6.27	2	9
Ship Handling	**Istanbul**	13	6.15	1.068	.296	5.51	6.80	5	9
	Rotterdam	46	6.48	1.243	.183	6.11	6.85	2	9
	Messina	29	5.72	1.279	.237	5.24	6.21	3	9
	Singapore	33	5.76	1.173	.204	5.34	6.17	3	8
	Dover	19	5.74	1.368	.314	5.08	6.40	3	9
	Tanger-Med	33	6.21	1.474	.257	5.69	6.73	3	9
	Total	173	6.06	1.306	.099	5.86	6.25	2	9

To better visualize the data gathered, figure 3.1 displays a graph of the means of each topic by scenario.

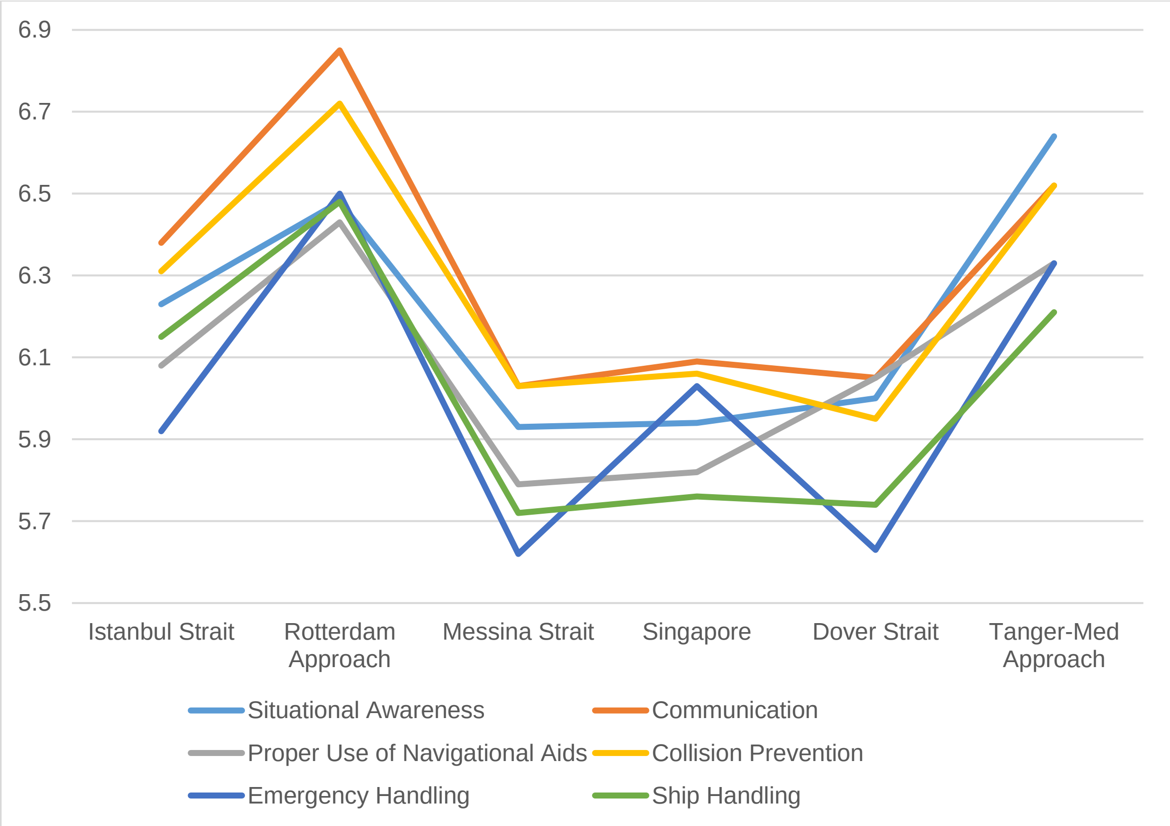


Figure 3.1: Line Graph of the Means of Key Topic Scores by Scenario.

With the data gathered presented, we can now carry on with the analysis. ANOVA has one requirement, and two assumptions. (3, 4) The requirement is to have a sample size of minimum 30, which the study meets. One assumption is the independence of each group, as in the study each group is composed of different participants carrying out the same scenario, the independence assumption can be made. Another assumption is normalcy.

3.1. Data Homogeneity

An assumption of ANOVA is normalcy, that is, the homogeneous variances of identically distributed normal variables. To check if this assumption is met, we apply the Levene's Test on our variables. The Levene's Test examines if more than two groups all have equal variances of the same variable. This test is required as our sample sizes for each scenario, or population, are not equal to one another. The SPSS test results are shown in table 3.2

Table 3.2: Results of the Levene's Test.

	Levene Statistic	df1	df2	Significance
Situational Awareness	1.155	5	167	.334
Communication	1.302	5	167	.265
Proper Use of Navigational Aids	.986	5	167	.428
Collision Prevention	1.977	5	167	.085
Emergency Handling	1.145	5	167	.339
Ship Handling	.449	5	167	.813

To interpret this table, what should be known is that a significance value lesser than .05 shows that population variances are not equal (van den Berg, n.d.-b), which would mean our variances are not homogeneous. However, the table shows that the least significant results are acquired with the collision prevention variable with $F(5, 167) = 1.977$, $p = .085$ which is greater than .05 and thus, all our variables show equal variance between populations and are homogenous. With this we can conclude that the study satisfies the second assumption of the one way ANOVA analysis and thus we can proceed with it.

3.2. One Way ANOVA Analysis

With the ANOVA analysis, it's possible to determine if the variances in our variables carry statistical significance, and if so, proceed with post hoc tests to determine exactly which variances show statistical significance. Table 3.3 shows the SPSS one way ANOVA analysis results.

Table 3.3: Results of the one way ANOVA analysis.

		Sum of Squares	df	Mean Square	F	Significance
Situational Awareness	**Between Groups**	14.640	5	2.928	1.947	.089
	Within Groups	251.163	167	1.504		
	Total	265.803	172			
Communication	**Between Groups**	18.927	5	3.785	2.849	.017
	Within Groups	221.894	167	1.329		
	Total	240.821	172			
Proper Use of Navigational Aids	**Between Groups**	12.275	5	2.455	1.576	.170
	Within Groups	260.176	167	1.558		
	Total	272.451	172			
Collision Prevention	**Between Groups**	15.743	5	3.149	3.165	.009
	Within Groups	166.129	167	.995		
	Total	181.873	172			
Emergency Handling	**Between Groups**	20.545	5	4.109	3.064	.011
	Within Groups	223.975	167	1.341		
	Total	244.520	172			
Ship Handling	**Between Groups**	17.198	5	3.440	2.080	.070
	Within Groups	276.224	167	1.654		
	Total	293.422	172			

Somewhat opposite of the Levene's Test, a significance value lesser than .05 in ANOVA analysis indicates that the results are statistically significant (van den Berg, n.d.-a). Collision prevention again has the lowest significance with $p = .009$, with communication and emergency handling also having significance values lesser than .05. This shows us that our results do carry statistical significance, and thus post hoc tests were carried out in order to investigate further.

3.3. Post Hoc Test

Due to the statistical significance of the one way ANOVA analysis, the results were further examined with a post hoc test namely the Tukey Honestly Significant Difference (HSD) test.

This was done in order to minimize any possible chance of drawing wrong conclusions, and to further determine statistically significant variances.

With this test, it can be determined on exactly which scenarios does the scoring for each variable differ significantly, and draw more conclusions from the results. In this section, the tests results will be given, however for brevity, only the results which actually show statistical significance will be shown. Table 3.4 shows the results of the Tukey HSD test.

Table 3.4: Results of the Tukey HSD test.

Dependent Variable	**Scenario I**	**Scenario J**	**Mean Difference (I-J)**	**Std. Error**	**Significance**	**95% Confidence Interval**	
						Lower Bound	**Upper Bound**
Communication	Rotterdam Approach	Messina Strait	.813	.273	.039	.03	1.60
Collision Prevention	Rotterdam Approach	Messina Strait	.683	.236	.049	.00	1.36
Collision Prevention	Rotterdam Approach	Singapore Strait	.657	.228	.050	.00	1.31
Emergency Handling	Rotterdam Approach	Messina Strait	.879	.275	.020	.09	1.67

As can be seen in the table, the results of the Tukey HSD test align with the results of the one way ANOVA analysis, and the scenarios which show the statistically significant variances are identified. As mentioned before, only results which show statistical significance ($p < 0.05$) are shown. The results show us that there is a significant variance in the scores for communication, collision prevention and emergency handling between the scenarios Rotterdam Approach and Messina Strait, as well as significant variance in the scores for collision prevention between Rotterdam Approach and Singapore Strait.

4. DISCUSSION

In this chapter an evaluation of the analysis results are given, the drawn conclusions are discussed and further research opportunities are presented. A comparison between the found results and the literature cannot be made due to a lack of literature on the topic as discussed in the first chapter. Thus the first order of business is to determine the knowledge gaps found using the analysis results.

4.1. Determining the Knowledge Gaps

To determine the knowledge gaps, the topics in which a significant level of variance were handled separately by key points by referring back to the evaluation forms, scenario logs and discussing the results with the observers. The arrived conclusions are presented in this section.

4.1.1. Collision Prevention Knowledge Gaps

Referring back to the previous section, the mean collision prevention score difference between the Rotterdam approach scenario and the Messina Strait scenario is .69, while the same difference between Rotterdam approach and Singapore Strait are .66, both in favor of the Rotterdam approach scenario.

A look back at the scenario structure reveal a key difference between the mentioned scenarios. While the most major traffic is found within precautionary areas of the traffic separation schemes in the Messina Strait and Singapore Strait scenarios, no such area is present in the Rotterdam approach scenario. However, the Tanger-Med approach scenario also includes a precautionary area within the scenario scope, but the difference here is the apparent status of the participant's vessel.

In all three scenarios which include a precautionary area the participants are in the status of "give-way vessel" towards the other vessels in the area. In the Messina Strait and Singapore Strait scenarios, the participants' destination requires them to proceed with the same, or a similar, course within the precautionary area as they have been following in the traffic separation lane immediately before, however in the Tanger-Med scenario the participants are required to start a "cross" towards their destination port before entering the precautionary area.

After revisiting the scenario logs and the evaluation forms, as well as discussing these findings with the observers it was determined that the above mentioned situation caused confusion among the participants which scored lower than the mean score for their respective scenarios. Such observations were made commonly about these participants:

1. The participants, if following the same course as before entering the precautionary area, were treating the precautionary area as if it were an extension of the traffic separation lane.
2. The above mentioned situation resulted in the participants observing other vessels as vessels "crossing the traffic separation lane".
3. This has resulted in a false expectancy in the participants, in the form of these "crossing" vessels to be the give-way vessel in this situation, and themselves to be the stand-on vessel.

This has resulted in the identification of two knowledge gaps on the topic of collision prevention.

1. The participants have shown a knowledge gap on the status of precautionary areas within traffic separation schemes, as they should not be treated as extensions of the

traffic separation lanes but as areas in which the separation lane rules and obligations no longer apply.

2. The participants have shown a knowledge gap on the status of a vessel following a traffic separation lane, as COLREGs state that following a scheme does not relive any vessel of their obligations from any other rule, such as the crossing vessels situation. (IMO, 2003)

4.1.2. Emergency Handling Knowledge Gaps

As established before, there is a difference of .88 points between the mean emergency handling scores between the scenarios of Rotterdam approach and Messina Strait. Moreover, the Rotterdam approach scenario has the highest mean score of emergency handling with 6.50 points among all of the scenarios.

After revisiting scenario structures, a differing factor among the scenarios were noticed. The Rotterdam approach scenario involves an emergency of M.O.B. nature, while the Messina Strait scenario involves an emergency of collision/collision near miss nature. A key difference here is that an M.O.B. situation should be well prepared for as rescue drills should be carried out regularly (IMO, 1999) however, no such drill is required for the latter situation. The mean emergency handling score for the Tanger-Med scenario furthers this correlation as it too has an emergency of M.O.B. nature and has the second highest mean emergency handling score of 6.33 points.

Thus a conclusion was reached as follows; the participants have shown a knowledge gap on the handling of emergency situations that do not require regular drills on, such as collisions or collision near misses.

4.1.3. Communication Knowledge Gaps

As previously shown, the difference of the mean communication scores between the scenarios of Rotterdam approach and Messina Strait is .82 points. After reexamining the scenario structures and logs of both scenarios it was noticed that both internal and external communication intensity increased during the parts of the scenarios involving heavy traffic.

After revisiting the evaluation forms and discussions with the observers, it was noticed that in the applications of the Messina Strait scenario with lower than the mean communication scores certain common mistakes were made. These were identified as;

1. The participants have failed to prioritize action over external communication during emerging collision situations.
2. The participants have failed to take action if the external party has not reciprocated their communication attempts.
3. The participants have failed to clearly state their intentions to the external party.

From the above list of mistakes, the conclusion was drawn that the participants have shown knowledge gaps in the following areas:

1. Proper prioritization between taking effective action and external communication.
2. Clear and effective external communication techniques.

4.1.4. Observer Comments

After the analysis, during discussions with the observes they have made the following comment; Even though the analysis didn’t show variations that carry statistical significance on this topic, it was observed that the participants are generally lacking knowledge in proper utilization of RADAR, especially on the topic of proper RADAR range settings.

5. CONCLUSION

In this dissertation, a study to identify the knowledge gaps of oceangoing masters was conducted. To this end, simulator scenarios were prepared and these scenarios were carried out by oceangoing masters, the process was observed by experts and each scenario was scored. A one way ANOVA analysis was then conducted in order to analyze the results and identify the knowledge gaps.

The prior section identifies 5 different knowledge gaps in 3 different BTRM key topics among master level seafarers. The findings are significant as some, such as the knowledge gap on the topic of emergency handling in emergencies previously unprepared for, may seem like common sense others point us towards topics which are, to the author’s best knowledge, are not explored in deep. These findings can help determine topics of training for anywhere between competency evaluations of officers and masters to the training of students.

However, this study also births many new questions, any of which could be studied on their own. For example, although this study identifies knowledge gaps, there is no answer to what is the root cause of this lack of knowledge on the found key points, or topics.

Another question is the effect of rank on these knowledge gaps, as previously established all participants of the study were oceangoing masters. A question arises if the same results apply to officers, or is rank a deciding factor as well.

One final example of a further study could be the determination of a method for proper and effective training on any of these topics. But with all the questions answered, and asked, the author sincerely hopes that these findings will prove useful for creating a safer working environment for all seafarers.

References

Baylon, A. M., & Santos, V. (2011). The challenges in philippine maritime education and training. *International Journal of Innovative Interdisciplinary Research*, *1*(1), 34–43.

Belev, B., & Daskalov, S. (2019). Computer technologies in shipping and a new tendency in ship's officers' education and training. *IOP Conference series: Materials Science and Engineering*, *618*(1), 012034.

Burger, W., & Corbet, A. (1963). Radar simulator courses. *The Journal of Navigation*, *16*(2), 253–255.

Castells, M. l., Ordás, S., Barahona, C., Moncunill, J., Muyskens, C., Hofman, W., Cross, S., Kondratiev, A., Boran-Keshishyan, A., Popov, A., et al. (2016). Model course to revalidate deck officers' competences using simulators. *WMU Journal of Maritime Affairs*, *15*, 163–185.

Corovic, B. M., & Djurovic, P. (2013). Research of marine accidents through the prism of human factors. *Promet-Traffic & Transportation*, *25*(4).

Cunha, J. (2019). Officer of the deck competency data collection and analysis.

Elashkar, M. A. (2016). The use of simulation techniques in the development of non-technical skills for marine officers. *International Journal of General Engineering and Technology (IJGET)*, *5*(5), 19–26.

Emad, G., & Roth, W. M. (2008). Contradictions in the practices of training for and assessment of competency: A case study from the maritime domain. *Education+ Training*.

Ernstsen, J., & Nazir, S. (2020). Performance assessment in full-scale simulators–a case of maritime pilotage operations. *Safety Science*, *129*, 104775.

Fawcett, K. (2018). Assessing today's bridge officers: Nsap: A powerful tool for dynamic evaluation. *Coast Guard Journal of Safety & Security at Sea, Proceedings of the Marine Safety & Security Council*, *75*(3).

Fjeld, G. P., Tvedt, S. D., & Oltedal, H. (2018). Bridge officers' non-technical skills: A literature review. *WMU Journal of Maritime Affairs*, *17*(4), 475–495.

Ghosh, S. (2017). Can authentic assessment find its place in seafarer education and training? *Australian Journal of Maritime & Ocean Affairs*, *9*(4), 213–226.

Ghosh, S., & Bowles, M. (2020). Challenges and implications in achieving content validity of an authentic assessment task designed to assess seafarer's leadership and managerial skills. *WMU Journal of Maritime Affairs*, *19*(3), 373–391.

Ghosh, S., Bowles, M., Ranmuthugala, D., & Brooks, B. (2014). Reviewing seafarer assessment methods to determine the need for authentic assessment. *Australian Journal of Maritime & Ocean Affairs*, *6*(1), 49–63.

Godwin, R. P., Eddy, P. P., & Longaker, R. K. (1959). Safety on the nuclear ship savannah. *Public Health Reports*, *74*(8), 669.

Gusenbauer, M. (2019). Google scholar to overshadow them all? comparing the sizes of 12 academic search engines and bibliographic databases. *Scientometrics*, *118*(1), 177–214.

Habberley, J. S. (1988). *Use of marine simulators for assessment of merchant navy deck officer competence* (Doctoral dissertation). University of Southampton.

IMO. (1999). *Solas: International convention for the safety of life at sea, 1974 : Resolutions of the 1997 solas conference relating to bulk carrier safety*. International Maritime Organization.

IMO. (2003). *Colreg: Convention on the international regulations for preventing collisions at sea, 1972*. International Maritime Organization.

JIN-BIAO, C., KE-PING, G., DONG-XING, J., & XINQING, Z. (2015). Application of marine simulators to bridge the gap between theory and practice in brm teaching. *NO. TOPIC PAGE NO. 1 Ten Lessons in providing MET remotely by Quentin N. Cox 1 2. SAMTRA's road to e-Learning in the South African Maritime industry by Gregory Moss 15 3. Using multimedia to understand ship design by Ashok Mulloth 29 4. Innovative manoeuvring support by simulation augmented methods–on-board and from the shore methods*, 63.

Kartal, Ş. E., Uğurlu, Ö., Kaptan, M., Arslanoğlu, Y., Wang, J., & Loughney, S. (2019). An analysis and comparison of multinational officers of the watch in the global maritime labor market. *Maritime Policy & Management*, *46*(6), 757–780.

Kavanagh, B. (2006). The development of ship simulation assessment to complement written maritime examinations in ireland.

Kobayashi, H. (2005). Use of simulators in assessment, learning and teaching of mariners. *WMU Journal of maritime affairs*, *4*, 57–75.

Kobayashi, H., Ishibashi, A., & Nishimura, T. (2004). Assessment on mariner's competency. *Proceedings of the Korean Institute of Navigation and Port Research Conference*, 129–138.

Lupu, S., Pocora, A., Nicolae, F., Katona, C., & Lupu, E. C. (2016). The role of the maritime simulators in evaluating the practical competencies of graduated students in order to accomplish officer of the watch duties onboard vessels. *The International Scientific Conference eLearning and Software for Education*, *1*, 216.

Manuel, M. E. (2017). Vocational and academic approaches to maritime education and training (met): Trends, challenges and opportunities. *WMU Journal of Maritime Affairs*, *16*, 473–483.

Martı́n-Martı́n, A., Thelwall, M., Orduna-Malea, E., & Delgado López-Cózar, E. (2021). Google scholar, microsoft academic, scopus, dimensions, web of science, and opencitations' coci: A multidisciplinary comparison of coverage via citations. *Scientometrics*, *126*(1), 871–906.

Mazhari, S. (2018). *Competency of merchant ship officers in the global shipping labour market: A study of the 'knowing-doing'gap* (Doctoral dissertation). Cardiff University.

Mohović, D., Mohović, R., & Barić, M. (2015). Identifying skill gaps in the knowledge and teaching of colregs. *17th international conference of transportation science. ICTS, Shanghai, China*, 339–348.

Ross, A., Willson, V. L., Ross, A., & Willson, V. L. (2017). One-way anova. *Basic and Advanced Statistical Tests: Writing Results Sections and Creating Tables and Figures*, 21–24.

Saarheim, S., & Brown, S. (2016). Assessment of stcw competences aboard a maritime academy training vessel. *IAMU AGA 17*, 70.

Saeed, F., Bury, A., Bonsall, S., & Riahi, R. (2018). A proposed evidential reasoning (er) methodology for quantitative assessment of non-technical skills (nts) amongst merchant navy deck officers in a ship's bridge simulator environment. *TransNav, the International Journal on Marine Navigation and Safety of Sea Transportation*, *12*(3).

Salman, A.-K. M. D. W. (2013). The importance of using ship bridge simulation training to enhance the competency of masters and watch-officers: A case study of the iraqi dredging fleet.

Sampson, H., Gekara, V., & Bloor, M. (2011). Water-tight or sinking? a consideration of the standards of the contemporary assessment practices underpinning seafarer licence examinations and their implications for employers. *Maritime Policy & Management*, *38*(1), 81–92.

Scariano, S. M., & Davenport, J. M. (1987). The effects of violations of independence assumptions in the one-way anova. *The American Statistician*, *41*(2), 123–129.

Sellberg, C. (2017). Simulators in bridge operations training and assessment: A systematic review and qualitative synthesis. *WMU Journal of Maritime Affairs*, *16*(2), 247–263.

Sellberg, C., Lindmark, O., & Rystedt, H. (2018). Learning to navigate: The centrality of instructions and assessments for developing students' professional competencies in simulator-based training. *WMU Journal of Maritime Affairs*, *17*, 249–265.

Sendi, Y. (2015). Integrated maritime simulation complex management, quality and training effectiveness from the perspective of modeling and simulation in the state of florida, usa (a case study).

Torre, M., Giannoni, M., & Colzine, G. (2019). Investigating seafarers' hard and soft skills in maritime logistics: An orveraching approach. *Impresa Progetto Electronic Journal of Management*, (3), 1–20.

U.N.C.O.T. (2022). *Review of maritime transport 2022: Navigating stormy waters*. UN.

van den Berg, R. G. (n.d.-a). Anova – super simple introduction. https://www.spss-tutorials.com/anova-what-is-it/

van den Berg, R. G. (n.d.-b). How to run levene's test in spss? https://www.spss-tutorials.com/levenes-test-in-spss/

Weintrit, A., & Neumann, T. (2016). Considerations on maritime watch keeping officers' vocational training. In *Human resources and crew resource management* (pp. 103–106). CRC Press.

Zažeckis, R., Bartuseviciene, I., & Maksimavicius, R. (2009). New capabilities of the nt-pro 4000 full mission ship handling simulator in the assessment and evaluation processes at lithuanian maritime academy. In *Marine navigation and safety of sea transportation* (pp. 89–94). CRC Press.

Zhang, W. (2017). Assessing the competency of seafarers using simulators in bridge resource management (brm) training.

APPENDIX A

The below shown form is an example of the forms used for the evaluation process.

Participant No:		**Application Number**
Scenario Name:		
Situational Awareness	**Communication**	**Use of Navigational Aids**
Collision Prevention	**Emergency Handling**	**Ship Handling**
ADDITIONAL NOTES		

Ahmet Fırat Usta

CURRICULUM VITAE

Education

Bachelor's Degree

• Piri Reis University *(2014 - 2020)*

Maritime Transportation and Management Engineering

Master's

• Piri Reis University *(2020 - Ongoing)*

Identifying Knowledge Gaps in Master Level Bridge Team and Resource Management

Work Experience

BEKS

• Deck Cadet *(2018)*

Navigational watchkeeping, Cargo watch, Deck maintenance

Piri Reis University

• Asst. Specialist *(2020 - 2023)*

TRANSAS simulator system operations, Simulator scenario preparations, Overseeing simulator applications

Piri Reis University

• Research Assistant *(2023 - Ongoing)*

TRANSAS simulator system operations, Overseeing simulator applications, Master & officer level BTRM trainings

Academic Experience

Conference Presentations

• GCGW-2021

Thermo-economic Performance Evaluation For Ships Based On Manoeuvring Processes of Port

• GMC-2021

SWOT Analysis of Scrubber Installation On Ships