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Simulation training and assessment in maritime education and training

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SIMULATION TRAINING AND ASSESSMENT SYSTEM ON MARITIME EDUCATION AND TRAINING

By

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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): **.....**

(Date): **.....**

Supervised by: **.....**

Supervisor’s affiliation**.....**

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Abstract

Title of Dissertation: Simulation Training and Assessment System in Maritime Education and Training

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The dissertation is a study of the assessment of simulation training in Maritime Education and Training, with a focus on seafarers who are trying to obtain a Certificate of Competency as per the requirements of the STCW Convention. The technology in every aspect of the maritime industry is developing dramatically. The use of simulation systems in the Maritime Education and Training has also been prevailed in many countries. The exploitation of the advanced simulation training can promote required practical skills and ability of seafarers in order to perform functions as required by the STCW Convention. The simulator training can assist seafarers to put the theories and lectures that they have learned in the traditional classroom into practice. At the same time, the assessment done by the simulator can give a more exact result whether the candidate has passed or failed compared to a traditional assessment

This dissertation specifically targets the improvement of the Maritime Education and Training System in Myanmar, one of the seafarer supplying countries of the world. The candidates of the STCW related examination in Myanmar have suffered long duration of sitting for their particular examinations due to an insufficient number of examiners appointed by the Flag State and a growth number of candidates in every year. Moreover, they also have insufficient competency training relating to practical onboard duties due to lack of simulators.

This dissertation critically assess how simulators can be the essential tools for training and assessment of seafarers in Maritime Education and Training system for Myanmar. In every particular case, there will be the advantage and disadvantage which will need to be understood and corrected accordingly.

KEYWORDS: Simulator Training, Simulator Assessment, Examination System, STCW, MET, Qualified seafarers.

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List of Abbreviations

A/B	Able Seafarer (Deck)
AIS	Automatic Identification System
AR	Augmented Reality
ARI	Applied Research International
ARPA	Automatic Radar Plotting Aids
AtoN	Aids to Navigation
BMTC	Brilliance Maritime Training Centre
BoB	Band of Brother
BoE	Board of Examination
CoC	Certificate of Competency
COLREG	The International Regulations for Preventing Collisions at Sea 1972
DMA	Department of Marine Administration
DR	Deck Reckoning
ECDIS	Electronic Chart Display and Information System
ENA	Electronic Navigational Aids
EP	Estimated Position
ETA	Estimated Time of Arrival
GMDSS	Global Maritime Distress and Safety System
GPS	Global Positioning System
GT	Gross Tonnage
HF	High Frequency
IMO	International Maritime Organization
INTERCO	International Code of Signal
MAIB	Marine Accident Investigation Branch
MES	Myanmar Excellent Star
MET	Maritime Education and Training
MF	Medium Frequency
MMMC	Myanmar Mercantile Maritime Collage

MMU	Myanmar Maritime University
MNA	Myanmar Nautical Association
MRCC	The Maritime Rescue and Coordination Centre
MSC	Myanmar State Commercial
OOW	Officer Of the Watch
PGI	Pacific Global International
PMTC	Prosperity Maritime Training Centre
STCW	International Convention for the Standards of Training, Certification, and Watchkeeping for Seafarers, 1978
TSS	Traffic Separation Scheme
UNCTAD	United Nations Conference on Trade and Development
VHF	Very High Frequency
VR	Virtual Reality

1.0 Introduction

1.1. Background

The maritime industry nowadays is the largest sector of transportation all over the world and the growth of seaborne trade is still increasing dramatically. According to the record of the United Nations Conference on Trade and Development (UNCTAD, 2018), the total amount of seaborne trade reached over 11 billion tons in 2018. As seaborne trade is increasing day by day, the role of Maritime Education and Training (MET) for those who operate and control seaborne trade becomes critical in the area of the maritime industry. Every aspect of advanced technology, training aids and facilities also need to be introduced into the maritime education and training system in order to promote the competency of seafarers.

The introduction of training aids, including simulators, has been wide spread across the maritime industry and simulators are becoming essential tools for the upgrading and development of skills and knowledge for seafarers. The use of simulators in training and assessment enables seafarers to perform their duties and responsibilities in a proper and safe manner (Sellberg, Lindmark & Rystedt, 2018). Furthermore, traditional training methods for specific skills have focused only on the development of the individual. Training using a simulator can, however, combines individual and teamwork skills, which may make more efficient for the real situation (Håvold, Nistad, Skiri, & Ødegård, 2015). The use of simulators can also connect classroom knowledge with real-world experience.

As Myanmar is one of the seafarer supplying countries, Maritime Education and Training status shall be fulfilled with the Conventional requirement as per Standards of Training, Certification and Watchkeeping for Seafarers (STCW). Under the Union of Myanmar, the Department of Marine Administration (DMA) is responsible for the Maritime Education and Training system. The DMA has developed simulator training

for seafarers in some training institutions under the Flag but the assessment of the competency is still done using traditional oral examinations. The DMA is planning to change the examination system of deck seafarers' competency especially for those who will become officers from the rank of rating, i.e. Officer in charge of the Navigational Watch (OOW), according to STCW Reg II/I, from traditional oral examination style to a simulator-based examination system. The simulator-based examination system will relate to the navigational regulations to avoid collision (COLREG) and aids to navigation (AtoN). This dissertation expects to identify a proper plan to assist in the changing of the system.

1.2. Problem Statement

Following the rapid development of technology in the maritime industry, modernized navigational aids such as ARPA, ECDIS, and AIS are being equipped onboard ships. Automation and Digitalization can assist seafarers in every aspect of navigation, but specific training for those navigational aids is required for smooth operation. Most of the required training is practical and required to be done through use of simulators to achieve an effective learning outcome. On the other hand, according to the minimum requirements of the STCW Convention, the candidates for Officer in charge of a Navigation Watch, Mates and Master Competency are required to learn about the basic principles of navigation using the traditional navigational instruments such as sextants, the planning of the passage; and the traditional method of obtaining the position of the ship with a sextant. The candidates have to spend a lot of time to meet both the standards of the STCW Convention and separate training on modernized equipment. However, by introducing bridge simulators, the candidates can complete both the basic principles of navigation and practical training at the same time.

Under the Union of Myanmar, the DMA is conducting traditional oral examinations for the certificate of competency (CoC) of deck and engineer officers. The candidates for the certificate of competency have to wait a long time to sit the examination due to the insufficient number of certified examiners. The candidates also have to provide

verbal answers in the examination room relating to the practical performance of the ship's navigation and collision avoidance. This makes it difficult to assess the actual knowledge, understanding and skills of the candidates. This issue could be solved by using bridge simulators as the assessment tool.

1.3. Motivation

Simulators can be regarded as state-of-the-art tools to test competencies directly, which meets the need of the industry. Presently, students are spending a lot of time memorizing the rules of collision avoidance and it is still not certain that they can take proper actions to avoid collisions. The strength of using simulators will be able to reduce or eliminate these barriers.

A simulator-based exam can have effective discrimination power to determine who is competent and who is not. Many other learning components could be assessed during simulator-based exam such as using bridge equipment, recording bridge activities, applying compass errors, communication in English, and team working skills. A simulator-based examination can be recorded and replayed whenever necessary and can also be used for debriefing after the assessment to avoid misunderstanding. Independent watch-keeping can be examined directly through the examination and can result in other non-technical skills such as situational awareness, confidence, decision making, alertness, and quick response. Traffic and communication response can be examined and oral English skills can also be improved. Furthermore, the simulator-based exam can, for example, create dense fog and restricted visibility so that blind pilotage techniques can be assessed and improved during the practice time. In addition, during the simulator assessment, emergency situation and decision-making practices can be examined, which is the most important action onboard the ship.

During the preparation time for the simulator-based exam, all candidates need to train with simulators for a reasonable period of time. They can gain experience, confidence, skills, and competency during their training. As a result of the simulator-based training

and assessment, they gain self-assurance for their practical onboard tasks and duties. STCW with its amendments adopted in 2010 sets the performance standards for all levels of competencies and each respective table indicates the KUP (Knowledge, Understanding and Proficiency) in one column and Method for demonstrating competence and Criteria for evaluating competence for each competency in the other columns. For demonstrating competence of each KUP, the simulator is regarded as one of the effective methods.

1.4. Aims and Objectives

The quality of a particular education can be decided in terms of input, output and process (Serbessa, 2006). These factors are related to each other in an educational system. The output, which can be referred to as the achievement of the students, has been too dependent the extent of inputs such as lecturers, instructors, teaching materials and facilities into the educational system. By drawing this concept into the MET system of Myanmar, if the country is eager to obtain reasonable standards in training and assessment, it is necessary to upgrade the facilities for seafarers' education and training. As Myanmar is a seafarer supplying country, it is necessary to raise the quality of seafarers to obtain a position as one the main seafarer supplying country. The shipping market, including supporting of seafarers, is generally a competitive market. Therefore, in order to produce a large number of seafarers, the country needs to establish an arrangement to reduce the period of training. On the other hand, the training needs to result in the necessary competencies to align with the STCW requirements and industry requirements.

The aim of this dissertation is to critically assessed how a mandatory simulator-based training and assessment scheme for seafarers' competency certificates in Myanmar's MET system can be introduced and to contribute to the production of quality seafarers in a reasonably short period. The scope of the research will include a review of the literature on the use of simulators as a tool for training and assessment purposes, a

review of International and National regulations on Maritime Education and Training, and an empirical research finding and analysis. Based on the research finding and analysis, the challenges will be defined, solutions will be identified and a proposal will be developed of a simulator-based training and assessment system in Myanmar. To achieve the purpose of the research, the following are the objectives of this dissertation:

1. to establish a new exam system with the effective use of simulation-based assessment in Myanmar;
2. to establish a Maritime Education and Training system in Myanmar, fully complying with the National and International standards;
3. to improve the quality and quantity of Myanmar seafarers and get more job opportunities;
4. to reduce unfair complaints to examiners during face to face examinations;
5. to reduce unnecessary waiting periods for exam by introducing simulator-based examination system.

1.5. Research Questions

1 What are the suitable assessment standards for simulator-based examination for certificate of competency?

2 How do the maritime institutions arrange the required facilities and infrastructure for simulator-based training and assessment for certificate of competency?

3 How do the Administration prepare curricula for simulator-based training and assessment for certificate of competency to meet required standards of the STCW Convention 1978, as amended?

4 What are the advantages and disadvantages of a new competency examination system for candidates?

1.6. Structure of the Research

This dissertation is structured into seven Chapters. The following Chapter 2 will cover the literature review about the widespread use of simulators and the requirements of the STCW Convention relating to simulator-based training and assessment. Chapter 3 will describe the methodology of the research, including data collection. Chapter 4 will discuss the current maritime training, education and assessment system in Myanmar and will show how the introduction of a new MET system can support the competency of Myanmar seafarers. Chapter 5 will present the analysis of the research findings based on the empirical research. Chapter 6 will propose a new system and discuss the outcomes of the analysis, including a framework for a new simulator-based training and assessment system for Myanmar. Chapter 7 will conclude the research and provide final recommendations.

2.0 Literature Review

2.1 Introduction

There is plenty of literature addressing the use of simulators for training and assessment in a maritime context. Simulators are mainly used in the training of high risk professions such as shipping, aviation, and healthcare in a risk-free manner (Dekker & van Winsen, 2009). The STCW Convention 1978, as amended, also prescribes the use of simulator-based training in the Maritime Education and Training (Reg: I/12 of STCW, 1978). This chapter of the dissertation will describe the importance of simulator-based training and assessment according to the STCW Convention and how simulator-based training and assessment can be improved in the context of the Maritime Training and Education system.

2.2 STCW Convention and The Use of Simulators

Every Party State to the STCW Convention has to ensure that the use of simulator-based training is well defined within its respective MET system. All training programmes need to be covered to meet the requirements of shipboard tasks and practices (STCW, 1978). During one of the major amendments of STCW 1978, the so called The Manila Amendments 2010, many of the simulator-based training including modern technology were introduced to comply by the member states mandatorily. The Manila Amendments to STCW 2010 entered into force on 01st January 2012 with major implications in respect of maritime education and training systems (Yabuki, 2011).As a result of the Manila Amendments to STCW 2010, major changes and amendments were seen in new methods of training in modern technology like electronic chart displays and information system (ECDIS), new requirements for able seaman to have a certificate of competency for boarding a vessel, inclusion of modern training methods such as distance learning and web based learning and new training regulations for ship staff in polar waters and personnel operating dynamic positioning systems are required to use simulator-based training.

The STCW Code Section A-I/12 defines standards regarding training and assessment with simulators. The member states to the Convention shall be required to fulfil the aims and objectives of simulator-based training which have been defined within an overall training programme. The specific training objectives and tasks are required to relate as closely as possible to shipboard tasks and practices (STCW, 1978). All the member states have an obligation to strictly follow the requirements of the STCW convention so that they can be approved as "White List" by the International Maritime Organization (IMO). The Union of Myanmar as one of the member states to the Convention has developed simulator-based training in all aspects of maritime training sectors. Under the Union of Myanmar, The DMA takes all responsibility regarding the training centres to effectively implement the requirements of maritime training by continuous monitoring.

2.3 General Overview for Training and Assessment with Simulators

The use of simulators for the purpose of training and assessment in the maritime industry is not a new process in many countries. Maran and Glavin (2003) suggest that the simulator environment has pedagogical advantages, which means that simulator exercises can create proper training and assessment for specific learning outcomes and be adjusted to the current competence level of students.

Firstly, consideration shall be made with regard to the increasing automation level onboard ships. Automation can create an environment with a reduced workload and reduced human resources for particular onboard assigned duties for both navigation and cargo handling (Hanzu-Pazara, Barsan, Arsenie, Chiotoroiu & Raicu, 2008). At the same time, we shall look into the maritime accidents involving higher level errors from human beings. Most maritime accidents occur due to a lack of situational awareness and wrong decision-making (Grech, Horberry & Smith, 2002). They also argued that the consequences of increasing technology may lead to the loss of

situational awareness. In order to follow the current technology trend, it is not possible to waste time totally immersed in lecture rooms. Practical training with all possible simulators can promote familiarization with new technologies and situational awareness for human resources, one of the important factors for the maritime industry, to achieve a high standard of shipping. Moreover, the IMO developed the STCW Convention to prescribe the minimum required standards for seafarers to perform their duties in respective functions such as navigation, cargo handling and maintenance. In every function of the STCW Convention, simulator can assist to effective outcomes of the training.

2.4 Challenges in the use of Simulators in MET

The investment in simulation facilities of simulator-based has involved many challenges and constraints for particular maritime institutes. The simulators often do not meet their expectations for many reasons and are very expensive (Farmer, Van Rooij, Riemersma, & Jorna, 2017). One of the significant challenges for the maritime institutes in order to invest in simulator-based training and infrastructures is the allocation of budget.

Most maritime institutes in many countries are dependent on private funding. In that case, investment in simulators is highly dependent on many considerations such as the shipping market, demand for seafarers, competition with other institutes, student enrolment numbers, and rising costs in training facilities.

Furthermore, according to the STCW Convention, 1978, instructors conducting simulator-based training are also required to be well-qualified persons in accordance with the provision of Section A-I/6 of the STCW Code. In order to meet the requirements of the STCW Convention, most of the member states are promulgating the qualification of the simulator-based training instructor to have an approved

certificate in compliance with the IMO Model Course 6.10[1]. For this reason, the insufficient number of instructors for simulator-based training may also become a challenge for maritime institutes. On the other hand, due to the fluctuation of the shipping market, the demand for and supply of seafarers becomes volatile in every supplying country. This could affect the training institutions, especially when they are going to decide to make more investments such as new simulator-based training.

2.5 The Usage of Simulator in Maritime Training

Simulators can be regarded as effective tools in maritime education and training. They can provide for the improvement of knowledge, skills and proficiency within various levels of responsibility from normal shipboard operations to complicated performance, duties and tasks. Training with simulators can transfer the competence acquired in learning to real life situations (Cross, 2019b). The training process with simulators normally includes three important steps that afford different material and temporal conditions for instruction (Sellberg & Rystedt, 2015). Firstly, a briefing is to be conducted as an introduction before the assignment is carried out by the trainees. It is a necessary part of the training, defining how to carry out the assignment and the learning objectives (Wickers, 2010). Secondly, the trainees need to perform the assignment after, which will take place within the scenarios created to meet the training purposes. Finally, the debriefing will be carried out to review the performance and point out the mistakes or errors made during the training scenario in order to achieve better results in the future.

Simulators have been used for training purposes for a long time both in the maritime and aviation fields. Much of the literature demonstrates the extent to which simulators can mirror the actual situation. Passing over some years, there is ample evidence that the simulator can be regarded as an effective tool to enhance practical skills in many maritime areas such as navigation, cargo handling, radio communication and

[1] IMO Model Course 6.10, Train the Simulator Trainer and Assessor Course

machinery operations (Muirhead, 2004). The simulator can translate principles and concepts of theory into effective practical action.

Effective simulator-based training can lead to the development of non-technical skills such as situational awareness and decision making for the trainee (Saus, Johnsen, Saus & Eid, 2010). These skills are important for every seafarer, especially for senior officers in order to make immediate decisions correctly relating to the safety of ship and person, and protection of the marine environment. The use of simulator-based training can promote situational awareness and correct decision making in actual situations for seafarers. The theories and severe lectures in traditional classrooms may not fully grant practical skills and proficiency, especially in the competence-based training of maritime professionals. They can also have new experiences from various kinds of emergency training in the simulation, which they have never encountered before in their past-experience. These experiences and awareness will support them when they are engaging with the same scenario in an actual situation and need to decide on the correct action and performance.

At the same time, it is important for instructors to design the training scenarios as closely as possible to the real-world situation and avoid creating impractical exercises. Otherwise, it will be diverged from the purpose of training and lead to gaming. The instructor also needs to prepare exercises that are well-adjusted to the trainee in order to obtain the learning outcomes correctly and effectively. Furthermore, Sellberg (2017) suggests that the paramount passion in the human factor is to develop technologies that better fit the cognitive abilities of the user, developing safer systems in every part of the maritime industry. It can be seen in the connection between the ability of humans and the development of technologies how simulators can be constructed to contribute maritime related training and knowledge for users.

Simulators used in maritime trainings can normally be classified as one of three types depending on the levels of performance capabilities, namely full mission simulators,

multi task or semi mission simulators, limited task simulators and special task simulators. Similarly, simulators have been classified upon the navigational function by DNV GL as Class A – full mission simulator, Class B – a multi task simulator, Class C – a limited task simulator and Class S – a special task simulator. Kluji (2001) discloses that the use of different simulator types can be very well illustrated by giving the example of different kinds of maps. Kluji assumes the full mission simulator as the country road map. It is the most complex and comprehensive and covers the full functions of the systems. The semi mission and limited task simulators are compared to city plans which cover only a limited function. Finally, the special task simulator is seen as a tourist map as it can achieve higher accuracy of simulation in certain functions, but probably be limited to the scope of the simulation system.

2.6. The Usage of Simulator in Assessment

The desired learning outcomes cannot be produced effectively when there is no rigorously assessed (Raymond & Usherwood, 2013). It is important to determine the comprehensive assessment method for every education and training process. In all academic processes, the system for assessment is important to ensure the learning outcomes. The nature of assessment for the ability and knowledge for seafarers in the maritime industry is “competence-based” assessment, which is developed from the description of the particular outcomes defining the task and performance (STCW, 1978). The simulator can be well supported to evaluate these tasks and performances of trainees in different scenarios and conditions. On the other hand, according to research by Kavanagh (2006), many students suggest that simulator-based assessment is more difficult than the traditional exam system. They state that with the simulation exam it is not possible to erase and re-do on an answer if a mistake is made as the assessment is continuously proceeding in real-time. However, the students can obtain some benefits from simulator-based assessment such as a quick response from a particular situation, correct decision making and fewer mistakes compared to traditional assessments.

The simulator-based assessment scheme for the competency of seafarers will generally be involved in the evaluation of collision regulations from the Convention on International Regulations for Preventing Collisions at Sea, 1972 (COLREG) and the use of traffic systems in accordance with the general requirements of IALA. The COLREGs are legally defined rules that need to be followed by every mariner to avoid collisions at sea.

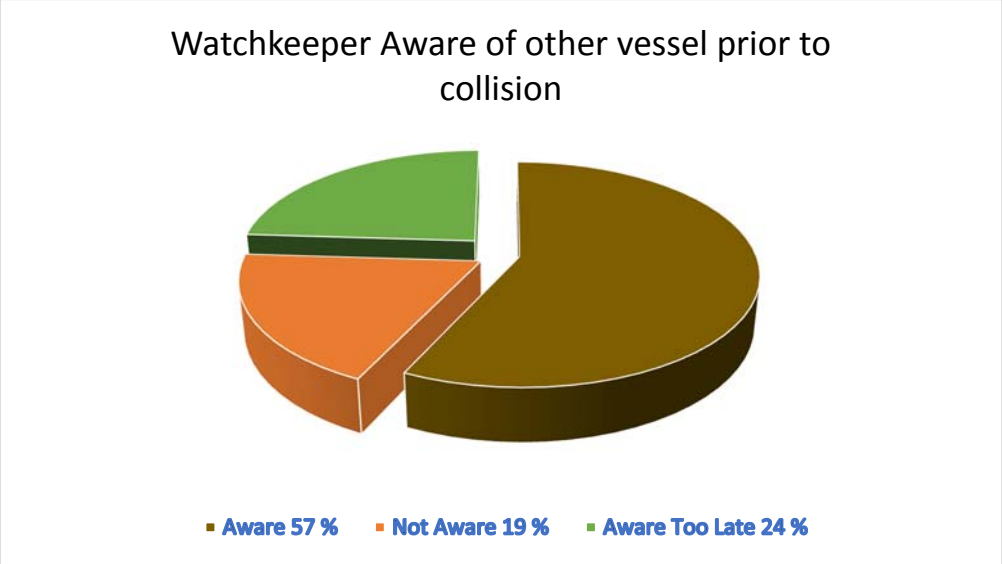

Figure 1 Analysis of Accidents

Figure 1 shows an analysis of marine accidents from 1994 to 2003 by the Marine Accident Investigation Branch (MAIB) safety study. According to the record of accidents by MAIB, collisions account for 55 % of all accidents, where 19% of the vessels involved in collisions were completely unaware of the other vessel before the collision; 24% of them became aware too late, and 57% of them were aware of the other vessel (Branch, House & Place, 2004). From the analysis above, the question arises as to why 57 % of collision accidents happened even though the OOW was aware of the situation. It clearly points toward the lack of required knowledge and

practical experience in maritime education and training of seafarers and negligence in respect of rules and regulations.

A complete understanding of the COLREGs is necessary for all Officers of the Watch on each vessel. They must know which rules have been applied in which situations and what proper action is needed to perform in order to comply with these rules (Belcher, 2002). In that case, the standard of assessment will assess the degree of their competencies in terms of the extent to which they understand the regulations to make the correct action in collision avoidance situations and the proper use of IALA buoyage system. According to the analysis by Demirel and Bayer (2015), some COLREGs Rules are difficult for students to understand especially Rule (9)[2] and Rule (10)[3]. These rules are concerned with the manoeuvring of the ship within the confined waters. Most accidents are likely to happen within these areas due to the limited movement of the ships. However, the use of simulators and practical exercises will facilitate learning of COLREG rules (Demirel & Bayar, 2015). Since most of the simulation scenarios have been created within such areas where accidents frequently can take place, the students are able to acquire the practical experience and knowledge for actual onboard actions and decisions. However, it is still necessary to strictly prescribe the required standard for the assessment process relating to the actions and performances taken by the student within the training. Otherwise, the simulation training will not be reflected by the students to be a realistic situation and will restrain the achievement of the expected level of learning objectives.

Ziarati (2006) also suggested that accidents were happening not because of insufficient rules and regulations, but because the existing regulations and standards are often ignored due to the deficiencies in the education and training of seafarers or disregard for current standards and regulations. This statement is reflected in the improper

[2] Rule – 9 – Narrow Channel
[3] Rule – 10 – Traffic Separation Scheme

standard of maritime training and the low degree of assessment schemes before issuing certificates of competency.

The tables of competence in the STCW Convention also state the various methods of evaluation of seafarers' competency and performance, such as simulators, in service experience, laboratory equipment, skills/proficiency testing software, projects, assignments, evidence from prior experience, computer-based assessment, written examinations and oral assessment (STCW, 1978). Among these methods, simulation can be the most extensive method to ensure the evaluation of the students by promoting both individual skills and team-working performance. Furthermore, the simulated scenarios with all variables are automatically recorded during the exercise. Review and debriefing can be available with the recording and replay of the entire exercise or selected segments from any point in the exercise to focus on a specific learning outcome.

Quality shipping in the maritime industry mostly depends on the quality of human resources working both ashore and onboard ships. IMO developed the STCW Convention in order to ensure the quality and competencies of seafarers to be consistent in every member state. The measurement for the standard of competency of seafarers becomes a vital part of ensuring that minimum requirements of the STCW Convention at met. However, Kobayashi (2005) stated that the STCW Convention does not mention enough about the assessment method relating to the required competencies of the seafarers. In that case, there may be different methods of assessment for competencies among member states based on the interpretation and availability of staff, facilities and equipment. Some member states use simulators as assessment tools while other use training ships, depending on the expenditure of budget.

Generally, the use of the simulators as an assessment method can be the optimum way of using the budget. It is more flexible in funding compared with the cost of a training ship and a more effectual method rather than the oral exam with ship models.

2.7. Sea-time Remission for Simulator-based Training

Currently, most countries are trying to reduce approved seagoing service with the substitution of the simulator-based training hours. For instance, according to the requirements of the STCW Convention Reg II/1, the minimum approved seagoing service for certification of officer in charge of a navigational watch on ships of 500 gross tonnage or more is prescribed as not less than 36 months. However, it can be possible to reduce the time to not less than 12 months if the candidate has conducted an approved training programme that meets the requirements of section A-II/1 of the STCW Code (STCW, 1978). The approved programme defined by the Convention includes both onboard training with official training record book and approved simulator-based training.

According to the Netherlands Maritime Study (1994), seagoing service for cadets has been reduced with the respective simulation time such that 5 days (40 hours) simulation time is equivalent to an actual 10 days of seagoing service; 10 days (80 hours) simulation time is equivalent to 30 days seagoing service and 15 days (120) hours simulation time is equivalent to 60 days seagoing service (Cross, 2019a). During the field study trip to the Philippines, the researcher observed that the Maritime Authority of the Philippines, MARINA, has also developed a 12-month training program for deck cadets, including both shore and onboard training. The training programme includes only 6 months of actual seagoing experience and the rest of the training period is conducted with simulators at the maritime institutions. It is cleared that these maritime countries are able to exploit the advantages of simulators as practical and approved training tools that meet with the minimum requirements of the STCW Convention.

2.8. Summary

In this section, it has been observed that the training and assessment of seafarers is one of the most fundamental factors in the development of the maritime industry. The STCW Convention and its amendments emphasise the minimum requirement of knowledge, understanding and proficiency of seafarers and their related duties onboard ships. The STCW Convention also prescribes various methods of training and evaluation for the competency of seafarers. Most member states to STCW Convention have used simulators as tools for training and assessment for seafarers in order to produce their Certificates of Competency at all levels of responsibility. It can be more consistent and reliable. For the purpose of developing the new system, the researcher will find out the proper solutions basically upon the research questions. These solutions will particularly provide the required standards for the assessment of seafarers' competency, the investment for necessary facilities, the development of new curriculum and the benefits for the introduction of a new training and assessment system in Myanmar.

3. Research Methodology

3.1. Introduction

The process of the research in a specific field can be defined as the systematic and scientific search for information about the specific topic (Kothari, 2004). The expectation of this dissertation is to develop a new training and assessment system in Myanmar for the improvement of seafarers' competency with the proper and wider use of simulators. Most of the training for the seafarers is practical training rather than principle and theory. According to this perspective, this research shall be conducted to introduce a new system of training and assessment by using simulators in future. The Maritime Education and Training system of Myanmar is also required to meet the current improvement of technology in the maritime industry.

The development of a new system of training and assessment can identify the weaknesses and requirements of the current system and address them in order to achieve a more effective training and assessment scheme in Maritime Education and Training. The researcher will mainly use the qualitative method in order to obtain the data and information by sending research questionnaires to the Maritime administrations and Training Institutions internationally. Data collection and analysis of the current traditional oral exam results for 2018 are also included to identify the weaknesses of the old examination and assessment system.

3.2. Data Collection and Analysis

The primary method of data collection for this dissertation was the qualitative method by developing the research questions addressing the statement of the problems for the introduction of new training and assessment system. This approach will be the link between the recent and potential problems identified by stakeholders and the successful introduction of the new system (Ayiro, 2012). The research questions cover four main areas, namely the required simulator-based assessment standard for

certificates of competency, the investment in simulator-based training, the development of new curricula for certificates of competency and the advantages/challenges of the new training and assessment system. The primary collection method of the necessary information was conducted among marine administrations and maritime training institutions from different countries by sending research questionnaires via email or social media. The secondary collection method of data relating to the seafarers' training and examination system for certificates of competency was gathered during field study trips to the United Kingdom, Norway and the Philippines. Additionally, some of the required information was obtained by conducting personal interviews via mail.

The analysis of the data and information was based upon the responses to the survey questions by the different organizations. It includes the determination and evaluation of gathered data in terms of what percentage of participants agreed or disagreed with the particular research questions. The review and perspective of relevant literature and experiences from the field study trips is also included to high-light the empirical research findings. Finally, the conclusion and recommendations will be drawn for the introduction of a new simulator-based training and assessment system considering the balance of advantages and disadvantages.

3.3. Ethical Issues

The accurate consideration of ethical issues is required to ensure no harm to the participants and their organizations as the research is related to human involvement. To that end, the procedures and guidelines from the World Maritime University Ethics Committee were strictly followed in order to obtain data and feedback from every participant. The research shall be proceeded through for the profit to the training and assessment of the seafarers' competency without any unreasonable demand from the organizations and participants.

The research involved the participation of maritime authorities and training institutions of other developed countries, outside of Myanmar, that are currently engaging with simulation-based training and assessment systems. Regarding this matter, the researcher ensure that their participation was completely voluntary and free from coercion or pressure. The researcher continuously maintained the participants' confidentiality and anonymity (Ritchie, Lewis, Nicholls & Ormston, 2013). Finally, the research results and data accurately reflect the data collect from the sources and have not been modified or changed in any way to acquire the desire result of the researcher.

3.4. Expected Results and Potential Limitations

The research explores the best results and outcomes to support maritime education and training in Myanmar. The candidates will obtain some benefit from the development of a new training and assessment system such as remission for the time spent on training and assessment in order to receive their respective certificates of competency. They will also gain some practical problem-solving skills from the simulator-based training and assessment. The frequency of exams will be increased by using simulators in future. At the same time, the overloading of examination processes will be reduced for the examiners, which will allow them to carry out other maritime-related functions under the Flag State rather than conducting traditional oral exams in a room for a whole day. Moreover, Myanmar's seafarers who are in compliance in accordance with the new simulator-based training and assessment under the required standard of the STCW Convention will have more job opportunities in the competitive shipping market.

However, since the research uses a qualitative approach, there will be some deliberations for potential constraints and vulnerabilities. According to Bowen (2006), a potential issue with this kind of research method is that a particular problem could go unnoticed. Moreover, depending on the nature of the research, it is necessary to use a large number of participants, which may lead to labour intensive analysis (Elo & Kyngäs, 2008). There may also be some barriers and uncertainty when collecting data

from human resources, especially in respect of sensitive questions such as those related to their salary, family and information about their organizations. Additionally, there is the potential for misunderstanding of the questions in many cases. Moreover, the purpose of the research is to modify the system of maritime training and assessment with the substitution of simulators instead of traditional teaching and assessment methods. This would be a high expenditure process for both maritime training institutions and administrations taking into account regular maintenance and upgrading of software as necessary. The instructors and assessors must be well experienced and familiar with the system and theory relevant to simulator-based scenarios since the simulators are easier to make a candidate fail or pass with high degree of sensitivity. In that case, the research should prepare for the resistance of different organizations with different perspectives.

4. Review of the Maritime Education and Training System of Myanmar

4.1. Introduction

This section will discuss the challenges and weaknesses of the current MET system in Myanmar. Being a developing country, modern technologies such as simulators have not been widely used for maritime training and assessment purposes. However, the DMA is planning to change the examination system of deck seafarers' competency from the traditional oral examination style to a simulator-based assessment system with the approval of the Ministry of Transport and Communications. It will cover the areas relating to the International regulations to avoid collision (COLREG) and aids to navigation (AtoN). Most of the countries such as Singapore, Philippines, China, Indonesia, England and Australia have been using simulator-based examination systems for several years. Myanmar is also trying to introduce the new system of examination, focusing on improving the ability and competency of the seafarers and supporting the objective of IMO: "Safe, Secure and Efficient shipping on Clean Oceans".

The introduction of a new training and assessment system may encounter many questions in relation to comparing existing and future results in the industry. Is it possible for the simulator-based examination system to replace the traditional oral exam? What will be the expected results? Can the simulators produce fair and accurate outcomes for the assessment of competency? Have the training institutions organized the necessary infrastructures for simulator-based training? What are the prospects for the students? This research will explore the answers to these questions and review the gaps by focusing on the advantages and benefits of using simulators in maritime related training and assessment processes. Before the introduction of a new training and assessment system, it is necessary to study how training and assessment has been carried out and identify the current challenges and difficulties for the maritime education and training system in Myanmar.

4.2. Review of Approved Seagoing Service

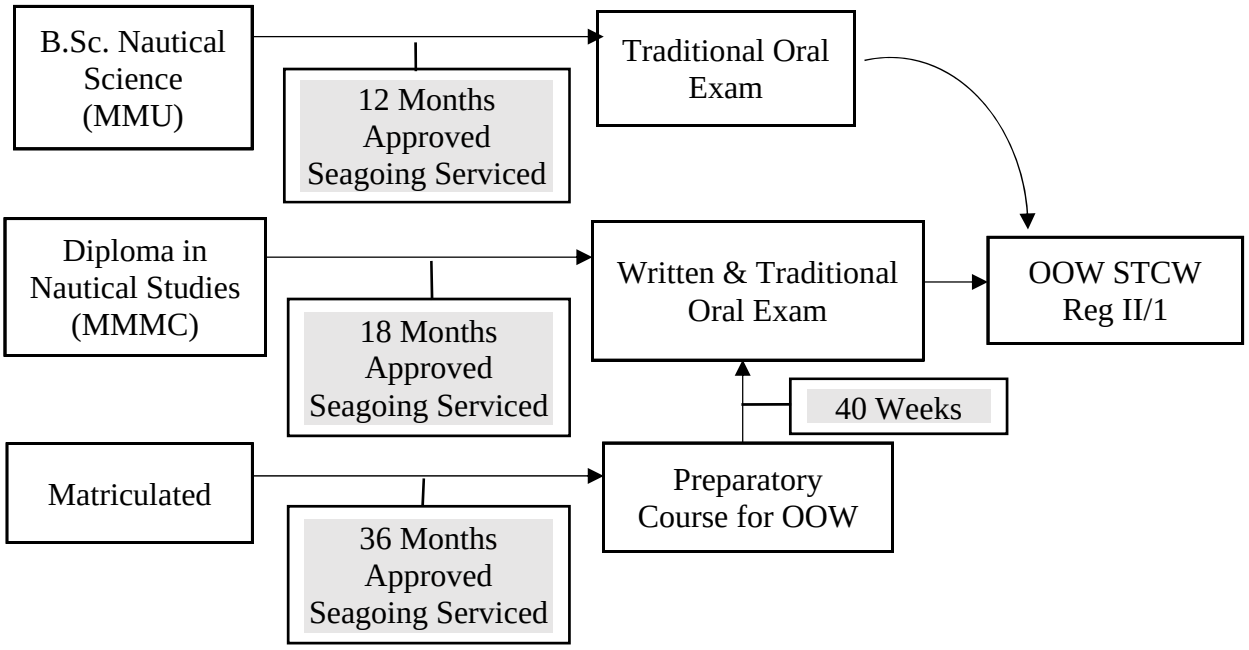

Figure 2 Training and Assessment System for OOW

Source: DMA (Notification 1/2014)

Figure 2 illustrates and explains briefly the current training and assessment system of Myanmar for the Officer in Charge of Navigational Watch according to the STCW Reg II/1.

According to the current system, all candidates for the Officer in Charge of the Navigational watch require approved seagoing service of not less than 36 months, except those who are engaging with an approved training programme (STCW, 1978). According to these requirements, DMA has allowed the candidates from Myanmar Maritime University and Myanmar Mercantile Marine College to conduct examinations with not less than 12 months in the approved training programme with a continuous record to ensure their training. These candidates are able to sit examination without attending the training courses. On the other hand, the candidates who have not

been met with the approved training programme are required to take the preparatory training course for 40 weeks to meet the requirement of Section A-II/1 of the STCW Code. For the purpose of this research, the researcher was eager to determine a possible approach to reducing the training duration for these candidates with the simulator-based training and assessment system in the future.

4.3. Review of Current Training System in Myanmar

Table 1 List of Private Maritime Training Institutions in Myanmar

No.	Name of Institutes	Sim/Training
1	Aung Tharaphu Maritime Training Centre	No
2	Brilliance Maritime Training Centre (BMTC)	Yes
3	Band of Brothers Specialized Tankers Training Centre (BOB)	Yes
4	BSM Maritime Training Centre	Yes
5	Cygnus Maritime Co; LTD	No
6	HTET OO Maritime Training Centre	No
7	Harmou Maritime Training Centre	Yes
8	Image Training Centre	No
9	JSM Maritime Training Centre	Yes
10	Kabar Maritime Training Service	No
11	Marico Seafarers Training Centre	No
12	M.T.M Maritime Centre	Yes
13	Myanmar Excellent Stars (MES)	Yes
14	Myanmar Nautical Association (MNA)	No
15	Myanmar State Commercial Training Centre (MSC)	No
16	Pacific Glory International (PGI)	No
17	Prosperity Maritime Training Centre (PMTC)	No
18	Unique Maritime Training Centre	No
19	Uniteam Training Limited	Yes
20	Win Ye Kyaw Maritime Training Company	No

21	Zay Yar Theikti Maritime Training Service	No

Table 1 shows the total number of training institutions in Myanmar. According to the table, the number of school using simulators for seafarers' training is identified. Only eight institutes, representing about 38 % of the total number, have recently used the simulator-based training in Myanmar. The rest of the maritime institutes have engaged the traditional teaching methods and facilities for their training courses.

The number of maritime institutes recently using simulators for training recently is likely to be insufficient to provide a new system for competency training and examination. As an example, the average number of candidates from each institute sitting for the examination of deck certificates of competency is about 100 students per term. If the simulator-based training and assessment for all deck certificates of competency has been promulgated as mandatory, it is not possible to cover all students only with eight numbers of institutes. To remedy this situation, more than half of the maritime institutes are required to develop facilities for simulator-based training and assessment. This research will focus on how the institutes fulfil the required standard of simulator-based training and assessment and identify the challenges they face when developing the new system of training and assessment using simulators.

It can be suggested that the students' ability to memorize is much better in the practical activities and exercises than in the traditional classroom activities. Most of the maritime training institutions in Myanmar are using traditional classroom activities and lectures. These traditional classroom activities can be a burden on the students, who have to memorize all the lectures without practical exercises. This may be even more pronounced for the operational level students, especially in terms of collision avoidance rules and regulations. The legal terms and usage of the rules and regulations are not familiar to them to learn easily, as it is their first experience. However, simulator-based training with practical exercises can be provided for students to recognize the concepts and actions required by these rules. As for the management levels students, these rules and regulations are not the first experiences for them to

learn and recognize. However, they can be achieved through more practical practices in the manoeuvring and handling of the ship in all weather conditions and different emergency situations. These practical experiences can be supported for them in actual operations of the ships, heavy weather conditions and in the case of emergency. These are some reasons that the simulator-based training needs to be developed in maritime education and training.

4.4. Review of Current Assessment System in Myanmar

The DMA, under the government of Myanmar, is acting as a single competent authority for all purposes relating to compliance with the STCW Convention including the exam for deck and engine certificates of competency. The department also notifies the national standard of minimum requirements, exam rules, system for training, examination and certification, including course outline and syllabus for written and oral assessment. For many decades in Myanmar, professional maritime competency has been assessed by the department through written examination and the traditional oral exam system, controlled by the Board of Examination (BoE). When the candidates have passed the written examination for the particular subjects according to the STCW Convention, they are allowed to conduct the oral examination to attain the Certificate of Competency (CoC). Modern technology such as simulator-based examination for the assessment of competency has not been conducted in the past.

Table 2 The Record of Exam Result 2018

Source: DMA (Exam Section)

No	Exam No.	Exam Total	Passed	Failed	%	Grade
1	1/2018	403	184	219	45.70 %	OOW
2	2/2018	342	194	148	56.73 %	OOW
3	3/2018	235	114	121	48.52 %	OOW
4	1/2018	188	77	111	41.00 %	Chief Mate
5	2/2018	168	83	85	49.40 %	Chief Mate

6	3/2018	145	67	78	46.20 %	Chief Mate
7	1/2018	69	32	37	46.38 %	Master
8	2/2018	53	20	33	37.74 %	Master
9	3/2018	54	22	32	40.74 %	Master
	Total	1657	793		47.86 %	

Table 2 shows the percentage of candidates who passed the respective exams for certificates of competency in the year 2018. From the records shown in Table 2, it can be seen that the average number of passing student was around half of the total candidates consistently throughout the whole year. The consistency of the result shows that there is a problem with the traditional oral examination system because the result of competency-based examinations should not be constant and the same for all examinations. The percentages of the results show that an average number of 50 students out of 100 failed in every examination. In that case, either the system of training or the assessment needs to be reviewed in order to obtain better results for the competency of seafarers.

4.5. Summary

The training and assessment system currently used in Myanmar has been found to have some weaknesses. The introduction of a new simulator-based training and assessment can be useful and effective for Myanmar's MET and for the competency of seafarers. The expenditure for initialization of simulators in training and assessment processes is getting higher. However, benefits can be obtained in respect of effective training, easier evaluation of performance and training time saved for the seafarers. The purpose of this chapter is to point out why Myanmar needs to widely develop simulators as the major tool for the seafarer training and assessment, ensuring that the minimum required standards of the STCW Convention are met.

5. Findings and Analysis for New Training and Assessment Scheme

5.1. Introduction

This Chapter of the paper will present the analysis of the findings primarily based upon the responses and feedback from the questionnaires. The secondary method of data analysis, including the information and experiences from the field study trips and, the information obtained by mail from assessors and lecturers of maritime institutions especially instructed in simulator-based training are also included. Furthermore, some of the references to the literature shall be used to support the research findings to develop a new simulator-based training and assessment system in Myanmar.

5.2. Primary Analysis of the Research

The researcher has developed the questions that will reflect the necessary process of the research under four categories: The Assessment Standard for competency, Investment in Infrastructure for Simulator-based Training, Development of New Curriculum and the Benefits of a New Training and Assessment System. The research questionnaires were sent to maritime authorities and training schools of different countries. Thirty-four responses were received, providing feedback for the research purposes and process, from the Myanmar Maritime Administration, International Maritimes Training Institutions and other organizations from the United Kingdom, Kenya, South Africa, Fiji, India, Netherlands and Philippines. A small number of responses can lead to an inaccurate outcome for the research. In addition, the researcher will try to strengthen the outcome and results by supplementing the data from the questionnaires with the experiences from field study trips and the maritime literature relating to simulator-based training and assessment.

The participants in the research are maritime professionals such as ships' masters, officers, surveyors, lecturers and instructors from different countries and maritime organizations. The maritime experience of participants ranged from 5 years to more

than 60 years in the industry[4]. They contributed their feedback and suggestions pertaining to the development of a new training and assessment scheme and the use of simulators in maritime education and training. Before developing a training and assessment system with the use of simulators, it is important to decide the extent to which simulators can replicate reality. To that end, the researcher developed the following research question.

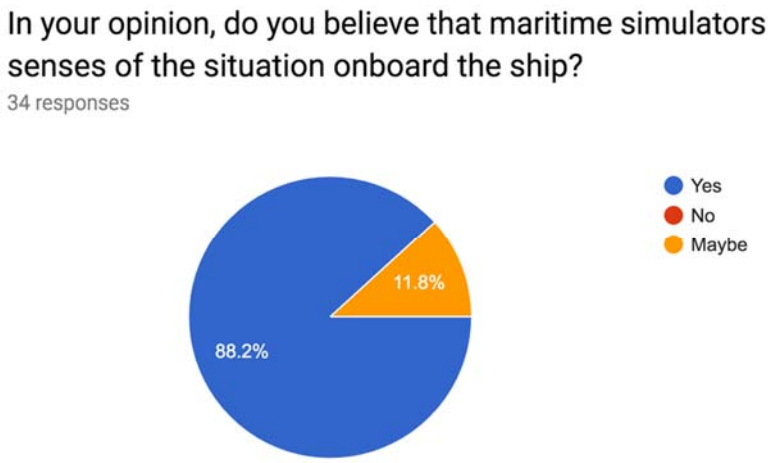

Figure 3 Research Presentation 1

Most of the participants (88.2%) are of the opinion that maritime simulators can recreate the actual situation onboard the ship, taking into account the characteristics, efficiency and limitations of the equipment. On that basis, the research progresses as follows to evaluate the necessary findings.

5.2.1. The Minimum Standard for Simulator-Based Assessment

Firstly, the researcher prepared the question – "What is the minimum required standard for simulator-based assessment for the certificates of competency?" The degree of assessment is important for the achievement of necessary learning outcomes. By using the questionnaires, the researcher has attempted determine the required standards for

[4] See appendix 4 for detail information

the assessment of competency. The questionnaires were designed to promulgate the optimum standard for the simulator-based assessment for the candidates as three options as follows;

“If the simulator-based assessment is used for collision avoidance rules and aids to navigation for all deck certificates of competency, the candidates should be passed when they could make,”

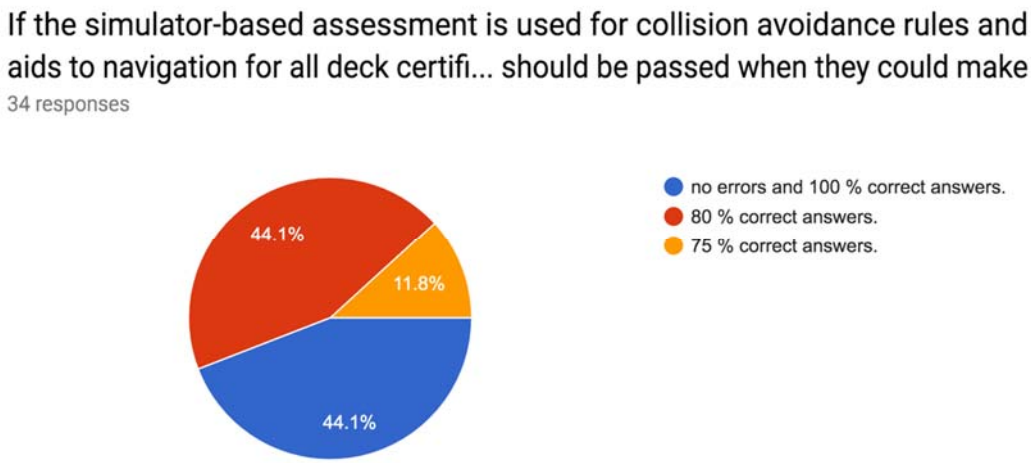

Figure 4 Research Presentation 2

Thirty-four responses were received from different organizations and most of them, almost 44.1% of participants, suggest 80 to 100% correct actions to be done in the simulator-based assessment of the COLREGs rules and regulations. These responses are aligned with the researcher’s own aspiration.

The existing system of oral examination for deck officers uses the same principle of no single error. The candidates cannot make any mistakes while attempting to answer the COLREGs rules and regulations because collision is one of the major sources of accidents at sea causing serious injuries, loss of life and damage to maritime property. As the COLREGs rules for all deck certificates are critically important for the safety of ship, cargo and marine environment, the level of assessment shall be raised to ensure

a high degree of understanding and application by the candidates. Even if the candidate commits a single error regarding the collision avoidance rules, there will be a breach of safety and the situation will lead to unavoidable danger of navigation in actual circumstances onboard the ship. Some of the system and software errors by the simulators shall be taken into account during the examination time. In order to decide the structure of the examination, i.e., how the exam should be conducted, the researcher developed the following question;

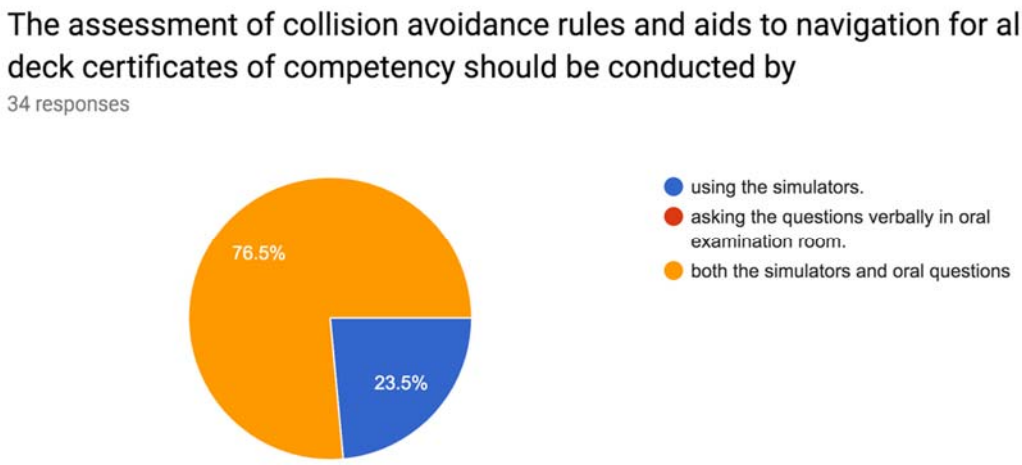

Figure 5 Research Presentation 3

It is important to decide whether the simulators alone are enough to test the competency for the relevant certificates. According to the research findings, shown in Figure (5), verbal questions still needed to be conducted with the candidates after simulation tests. These questions will ensure some of the competences which cannot be covered by the simulator-based assessment.

5.2.2. Investment in Simulator-Based Training

Secondly, it is important to decide the optimum method to invest in the required training facilities to meet the requirement of learning objectives for the particular training courses. When introducing the new scheme for simulator-based training and

assessment, many challenges and significant resistance may occur during the process. One of the significant challenges is the expenditure of budget on investment in the infrastructure for simulators. There may be no argument that the cost of simulators, including the maintenance of hardware and updating of the software, is higher compared with any other traditional training facility. However, it is necessary to conduct a cost benefit analysis to determine the extent to which the simulators can provide the maritime industry looking for the long-term period. For the maritime institutions, the initial cost of introducing simulator-based training may be high. However, they can recover the investment from their revenue as long as they have an enrolment of students, the seafarers. In the long term, the seafarers will suffer the consequences of developing the simulator-based training and assessment system. Therefore, a careful analysis should me made of the benefits for seafarers as a return for the costs of simulator-based training and assessment. The research explores the benefits of using simulator-based training in terms of time consumption and achieving situational awareness compared with the cost of using such facilities in the following paragraphs.

5.2.2.1. Types of Simulator and Learning Outcomes

It is important to choose the right kind of training facilities to meet the required learning outcomes and objectives. There will be various levels of cost depending on the performance of maritime simulators. The investor has to carefully consider which types of simulators have been correctly used to meet the particular purpose of training and assessment. Most of maritime-related training is based on learning outcomes that state the required knowledge and skills to be achieved upon completion of the respective training courses. It is also necessary to decide what kinds of teaching methods and training aids are to be used in order to obtain the desired learning outcomes. For example, the training institutions do not need to use full mission simulators to conduct helm training for the AB (Able-Bodied Seafarers Deck). Relating to this issue, it is necessary to choose the proper kind of simulator in order to

develop the training and assessment system for seafarers' certificates of competency. The following research question was prepared to decide the optimum type of simulator;

"What types of simulator are required to meet the minimum standards of training and assessment for all deck certificates of competency required by the present STCW Convention?"

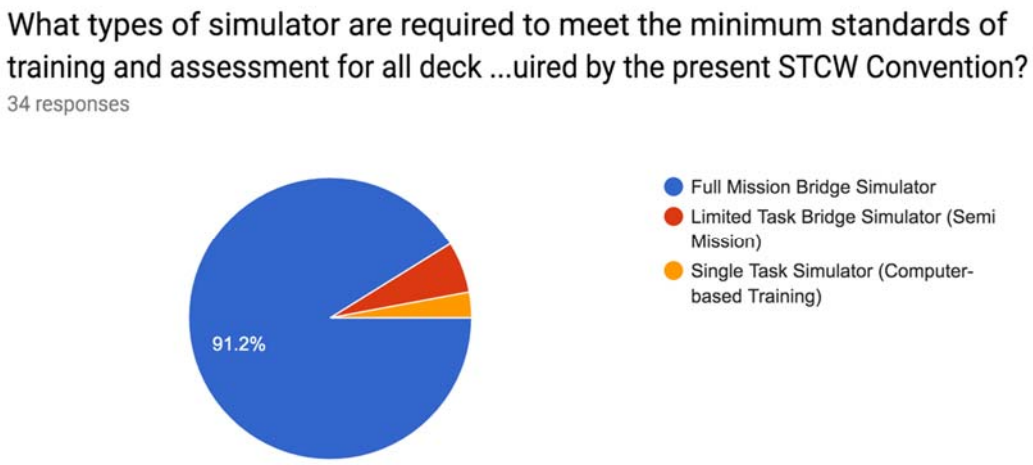

Figure 6 Research Presentation 4

In this case, the researcher has decided to introduce full mission bridge simulators taking into account the thirty-four responses recommending the choice of full mission bridge simulators. The training and assessment for competency with the assistance of simulators will have to be designed to meet the standards of the STCW Convention. It shall also have a sense of the actual situation in which the full mission bridge simulators can be provided. As an example, Table 3 illustrates the necessary functions of bridge operations and capabilities of different simulator classes according to the IMO Model Course 6.10[5].

[5] Train the Simulator Trainer and Assessor

Table 3 Bridge Operation and Classes of Simulator

STCW Reference	Competence	Class A	Class B	Class C	Class S
Table A-II/1.1	Plan and conduct a passage plan and determine position	A	B		S
Table A-II/1.2	Maintain a safe navigation watch	A	B		S
Table A-II/1.3	Use of Radar and ARPA to maintain the safety of navigation	A	B	C	S
Table A-II/1.4	Respond to emergencies	A	B	C	S
Table A-II/1.5	Respond to a distress signal at sea	A	B	C	S
Table A-II/1.8	Manoeuvre the ship	A	B	C	S
Table A-II/2.1	Plan a voyage and conduct navigation	A	B		S
Table A-II/2.1	Determine position and accuracy of resultant position fix by any means	A	B		S
Table A-II/2.3	Determine and allow for compass errors	A	B		S
Table A-II/2.4	Coordinate search and rescue operations	A	B		S
Table A-II/2.5	Establish watchkeeping arrangements and procedures	A	B		S
Table A-II/2.6	Maintain safe navigation through the use of Radar and ARPA and modern navigation system to assist command decision-making	A	B	C	S
Table A-II/2.9	Manoeuvre and handle a ship in all conditions	A			S
Table AII/2.10	Operate remote controls of propulsion plant and engineering systems and service	A			S

From Table 3, the capabilities of different classes of simulators for different levels of functions of bridge operations can be observed.

The Class-A, full mission bridge simulator, can be used for all necessary bridge operations required by the STCW Convention.

The Class B and C types of simulators have limitations and constraints as seen in Table 3. It is not possible to conduct the proper training and assessment process.

The special task simulators such as Radar, ARPA, ECDIS and GMDSS can provide all competences required by the STCW Convention. However, these types of simulators are not integrated and it is difficult to design a combined navigational scenario. In most maritime training, full mission bridge simulators are also regarded as especially beneficial for working on team-based activities and for training in realistic settings (Hancock, Vincenzi, Wise & Mouloua, 2008).

In that case, the research recommends adopting the full mission bridge simulator for the purpose of a new simulator-based training and assessment system for the competency certificates of seafarers.

5.2.3. Reduction of Training and Assessment Duration

The following research questions relating to the training and assessment period was prepared to determine how the duration of necessary training and assessment for Certificate of Competency can be shortened by the substitution of simulators;

“Do you believe that assessment time for all deck certificates of competency will be reduced by using the simulators rather than the traditional oral examination?

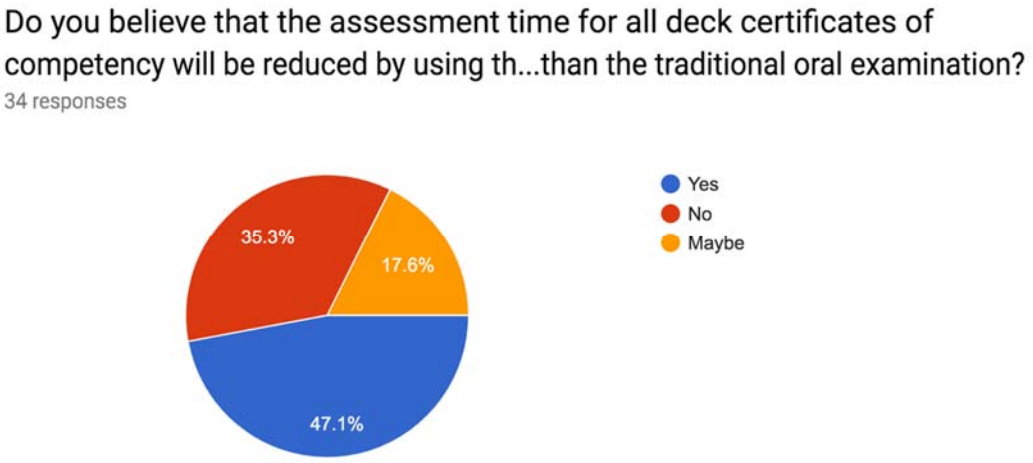

Figure 7 Research Presentation 5

"Do you believe that the training time for all deck certificates of competency will be reduced by using simulators rather than full of lectures in the classroom?"

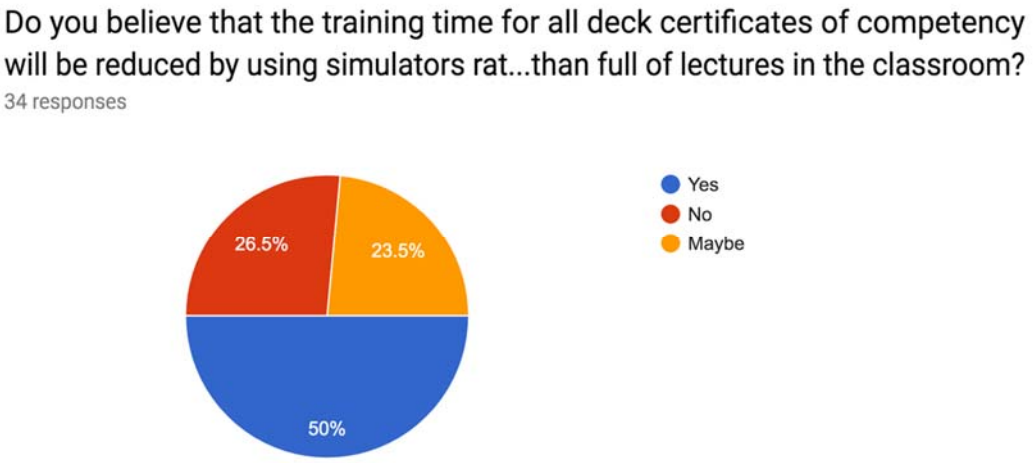

Figure 8 Research Presentation 6

According to Figure 7 and 8, participants contribute their suggestion that simulators can reduce the necessary training and assessment duration. Some of the navigation-

related duties such as planning and maintaining safe navigational watch are possible to perform within an integrated full mission bridge simulator. This can have a result of reducing the required teaching hours for a particular training course.

As an example, Table 4 describes the current training durations and teaching hours for the candidates for the certificates of the officer of the watch (OOW). According to the current system, the candidates will need a total of 40 weeks duration to complete their training course. Table 4 exposes the details of teaching hours for specific subjects for the OOW training course. On that basic, the possibility of reducing the teaching hours by the substitution of maritime simulators can be considered.

Table 4 Teaching Hours for OOW Training Course

Source: DMA (Notification 5/2016)

Semester	No	Subjects	Teaching Hours	Total Weeks
1st Semester	1	English	96	30 Hours/ Week
	2	Physical Science	108	
	3	Mathematics	96	
	4	Meteorology	60	
	Total Teaching Hours		360	12 Weeks
2nd Semester	1	Principle of Navigation	120	33 Hours/ Week
	2	Practical Navigation	48	
	3	Chart Work	60	
	4	ENA & Compass	100	
	5	Cargo Handling & Stowage	64	
	6	Stability & Construction	64	
	7	COLREG 72	72	
	Total Teaching Hours		528	16 Weeks

3rd Semester	1	Practical Navigation	84	30 Hours/ Week
	2	Passage Planning	60	
	3	Cargo Handling & Stowage	72	
	4	Stability & Construction	72	
	5	COLREG 72	72	
		Total Teaching Hours	360	12 Weeks
		Grand Total Teaching Hours	1248	40 Weeks

By observing Table 4, it is practicable to combine subjects such as Practical Navigation, Chart Work, Passage Planning and COLREG 72 into one consolidated subject that can be conducted with the use of a full mission bridge simulator. Accordingly, the training duration can be decreased as a single subject. The teaching hours for these mentioned subjects are 396 hours in total. However, it will not be necessary to use such a duration of teaching hours when developing one single curriculum for simulator-based training. For example, the trainee can complete the different subjects, such as collision avoidance actions, the principle of taking the navigational watch, the use of ships' routeing system, the procedure for bridge team work and responding to emergency, at the same time. As a result, the students can complete all the necessary training and knowledge relating to these subjects, and the required learning outcomes can be achieved in a full mission bridge simulator within a reduced period of training.

On the other hand, the system of assessment for collision avoidance rules is currently based on traditional oral questions with the use of ship models on the exam tables. One candidate normally takes about one hour to complete all the necessary assessments in the exam room. In total, three to four candidates can be assessed by exam board per day. The total duration for all candidates to fully complete the assessments will depend on how much exam boards can be extended for the particular assessment. Sometimes

the duration of assessment takes over two months depending on the number of candidates and available of exam boards.

According to the research findings and responses, the duration of assessment can also be reduced by introducing a simulator-based assessment system. Three to four candidates can be assessed simultaneously in the full mission bridge simulator with respective tasks for them to perform at the same time. For example, one candidate is assigned to carry out passage planning while others are carrying out the navigation, collision avoidance rules and use of the IALA traffic system. The tasks are then rotated for different functions and performances with different exercises. It is possible to complete assessment within approximately two hours depending on the level of competency. Based on this consideration, the total number of candidates that can complete assessments within a single day can be doubled compared with the traditional oral examination system. The time required to complete the assessment of all candidates will also be decreased to half and the frequency of exams for the annual period will be possible to increase. As a result, the seafarers do not need to waste their time unnecessarily in the training and assessment process. Even if the seafarers have used more expenditure for the simulator-based training and assessment, they have some advantages that it is possible to go back to their careers within a relatively short period time.

5.2.4. The Development of New Curriculum

Finally, it is important to develop the necessary curriculum for the new simulator-based training and assessment system. Curriculum development is one of the most important processes in education and training to ensure the expected outcomes. When it is decided to introduce a new system for simulator-based training and assessment in MET, the first is to prepare the National Curriculum for the new system. The new curriculum for the simulator-based training and assessment scheme is needed to design the planning, implementation and evaluation of the outcomes according to the

Lunenburg (2011). The standard of evaluation process should be aligned with the minimum standard compliance to the requirements of the STCW Convention Reg I/12 and Section A-I/12 of the STCW Code. The curriculum must effectively connect the interactive elements such as the simulator, well-motivated simulator instructors, well-designed training programme and the interested students in order to create a realistic simulator environment.

The researcher has designed the framework for the National Curriculum by asking the question “Do you think the simulator training and assessment for collision avoidance rules and aids to navigation should be mandatory in the curriculum for all deck certificates of competency?”

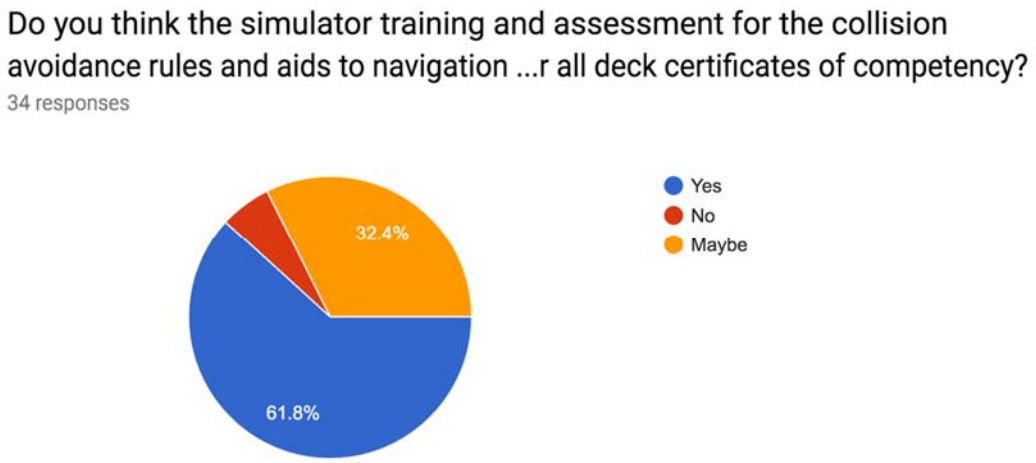

Figure 9 Research Presentation 7

According to Figure 9, almost all participants have agreed to be the mandatory system in the MET of Myanmar. Most of the responses are based upon the requirement of the STCW Convention Reg I/12, Use of simulators, and the STCW Code Section A-I/12, specifying the required standard for mandatory simulator-based training and assessment. However, it is still necessary to define the consequences of a mandatory simulator-based training and assessment system before preparing for the National Curriculum. The consequences of the mandatory simulator-based training and assessment in the National Curriculum will be the same challenges discussed in the

previous section of the dissertation. Most of the issues will be related to the expenditure of budget, location for the simulators, and insufficient numbers of certified simulator instructors and assistants.

According to the empirical research findings, the researcher observed that the curriculum for the new simulator-based training and assessment system will need to meet the needs of the Myanmar seafarers and their markets in the international shipping industry. The new curriculum requires a clear design of the practical learning outcomes, taking into account the necessary knowledge and skills for the seafarers to perform their tasks in the future. The stakeholders also need to be defined according to the involvement in the training and assessment system. The development of a new curriculum for simulator-based training and assessment is mainly concerned with the "Outcomes-based Integrative" model (Bell & Lefoe, 1998). Firstly, the curriculum must start with the specific outcomes that will reflect the required standard of competency for Myanmar seafarers. Secondly, the relevant teaching method, content, facilities and assessment standards relating to simulator-based training and assessment shall be designed for the final evaluation of seafarers' competency in compliance with the requirements of the STCW Convention and Code. Figure 10 illustrates the draft for the development of a new curriculum. The detailed information and outline of the curriculum will be described in the next section.

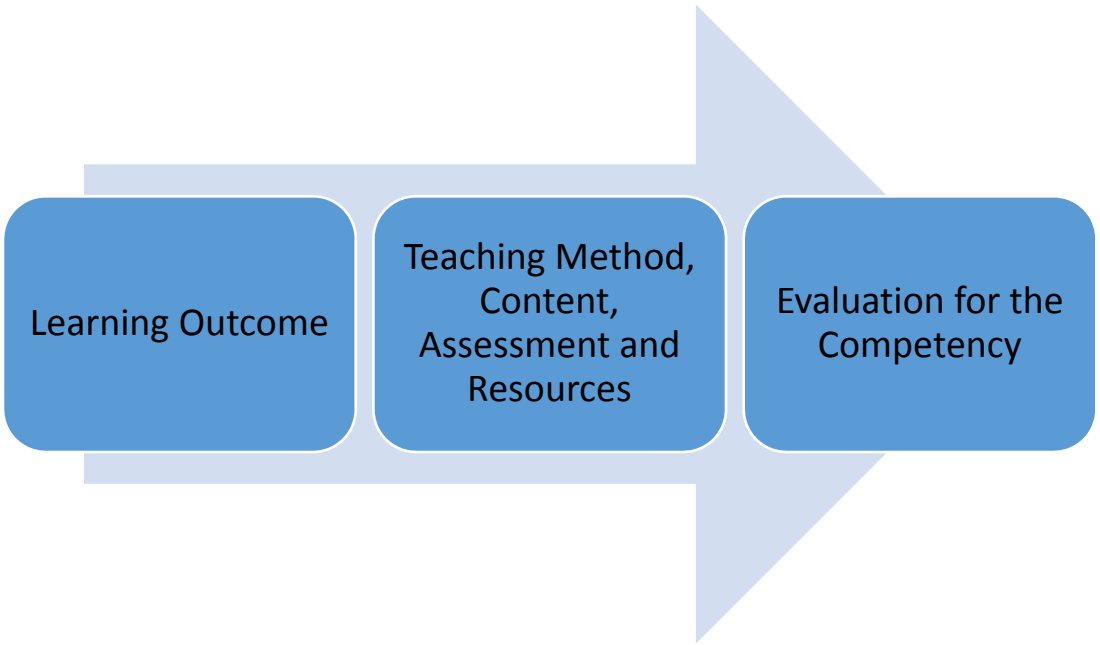

Figure 10 Outcome-Based Integrative Model

5.3. Secondary Analysis of the Research

This section will cover some of the research findings obtained during the field study trips and the information received by via mails.

5.3.1. Market and Technology Analysis of Maritime Simulators

The manipulation of the simulator market is also important and likely to impact on the maritime industry in many ways. This section of the paper identifies factors in the simulation market that are especially relevant to the maritime education and training sector. There are many companies in the maritime simulator market nowadays such as Kongsberg, Transas and ARI competing with each other by offering a large range of maritime training simulators. The simulator manufacturers have developed various technologies in order to meet the requirements of customer satisfaction and user-friendliness. The following paragraphs will disclose how the current technologies and

simulator market affect the training and assessment of seafarers in the maritime industry.

5.3.1.1. K-Sim Navigation System

During the field study trip to Norway, the researcher had the opportunity to observe the technology development of the Kongsberg simulator company. It is one of the major simulator companies in the world today. Wulff (2018) stated in Maritime Simulation Magazine that Kongsberg Digital had great influence on the introduction of K-Sim Navigation in 2018, which can be valuable for fundamental navigation training and assessment. K-Sim navigation performs as a new generation of navigation bridge simulators, designed for optimum user experience and featuring advanced and integrated simulation training in compliance with the standard of STCW Reg I/12. The significant feature of the system is a quick routing of ship traffic, which is regarded as a highly important tool for STCW related training. The system has allowed to insert the vessel, make a route and assign the specific task within 10 seconds, which is a relatively short period compared with other simulation systems. By taking advantage of the short time require to design the exercise, the instructor or the assessor can create many scenarios and emergencies within a limited period of assessment time.

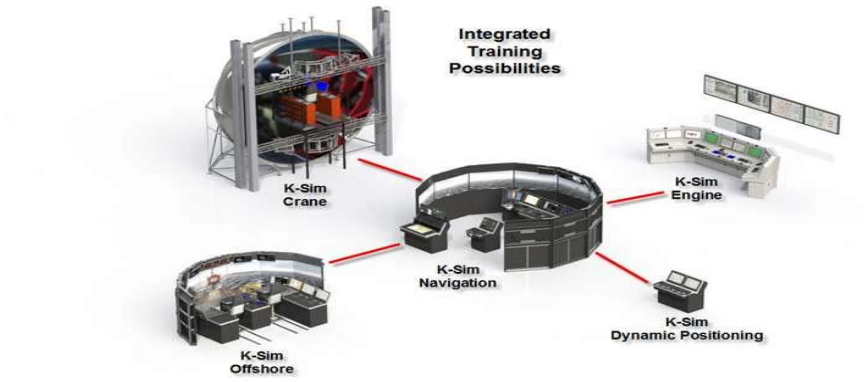

Figure 11 K-Sim Navigation and Integrated System

Source: K-Sim Navigation – KONGSBERG DIGITAL - kongsberg.com

5.3.1.2. Virtual and Augmented Reality (VR & AR)

The other forms of technological hardware are the development of virtual and augmented reality (Steuer, 1992). According to the Coates (1992), these systems can be defined as electronic simulations of environments experienced via head mounted eye goggles and wired clothing, enabling the end user to interact in realistic three-dimensional situations. Many of the simulation developers nowadays have introduced virtual reality simulation within the maritime industry. The system has designed the animation of human and physical processes for a specific task, which can provide realistic training for the actual situation and solution (von LUKAS, 2006). Individual simulation training provided by these systems can achieve a high level of decision-making in maritime-related emergency situations. This type of training is more relevant to individual skills and knowledge used for the investigation of specific problems to identify the proper solutions. Generally, the trainees can be supported to have a real sense of the situation in maritime education and training. However, it is not necessary to urgently develop the simulator-based training and assessment system, taking into consideration factors such as availability of the budget, instructors and the degree of the training requirement.

5.3.2. Simulation Markets in Myanmar Maritime Industry

Most of the maritime institutes in Myanmar are using Transas and ARI full mission bridge simulators for training purposes. The researcher has targeted some questions to the end-users of Transas and ARI maritime simulators in Myanmar via email, relating to their usefulness, limitations or constraints, and troubleshooting. All users from the training institutions recommend both types of simulators for their convenience of training and assessment processes. They also commented on the user-friendly system of hardware and software as these simulators are designed and developed under high-specification complex simulation system suitable for training and assessment processes. However, there are some minor technical problems during the operation

such as system breakdown after long period of operation. Moreover, the accuracy of the helm sometimes does not synchronize with the action by the operator. The simulator developers have designed a problem-solving method via online for their customers. They can assess the users' system remotely and fix the problems. However, it is important to find all expectable problems and to define the proper solutions before setting out the mandatory standards for the simulator-based training and assessment system.

5.4. Summary

This section of the dissertation has mainly focused on the responses and feedback from the questionnaires by the different organizations of different countries. By using some analysis based on the questionnaires, the researcher has tried to develop a new simulator-based training and assessment scheme for Myanmar Maritime Education and Training System. According to the responses from the participants, it can be deduced that simulators are not the best tools for training and assessment system; however, simulators can be considered as a reasonable and convenient method for achieving the expected outcomes of maritime education and training. This concept can take the researcher to the finalization of the framework for a new training and assessment scheme with the use of simulators for Myanmar's MET system as expeditiously as possible. The following diagram illustrates and reviews the brief result of the research findings to introduce new simulator-based training and assessment for the certificates of competency.

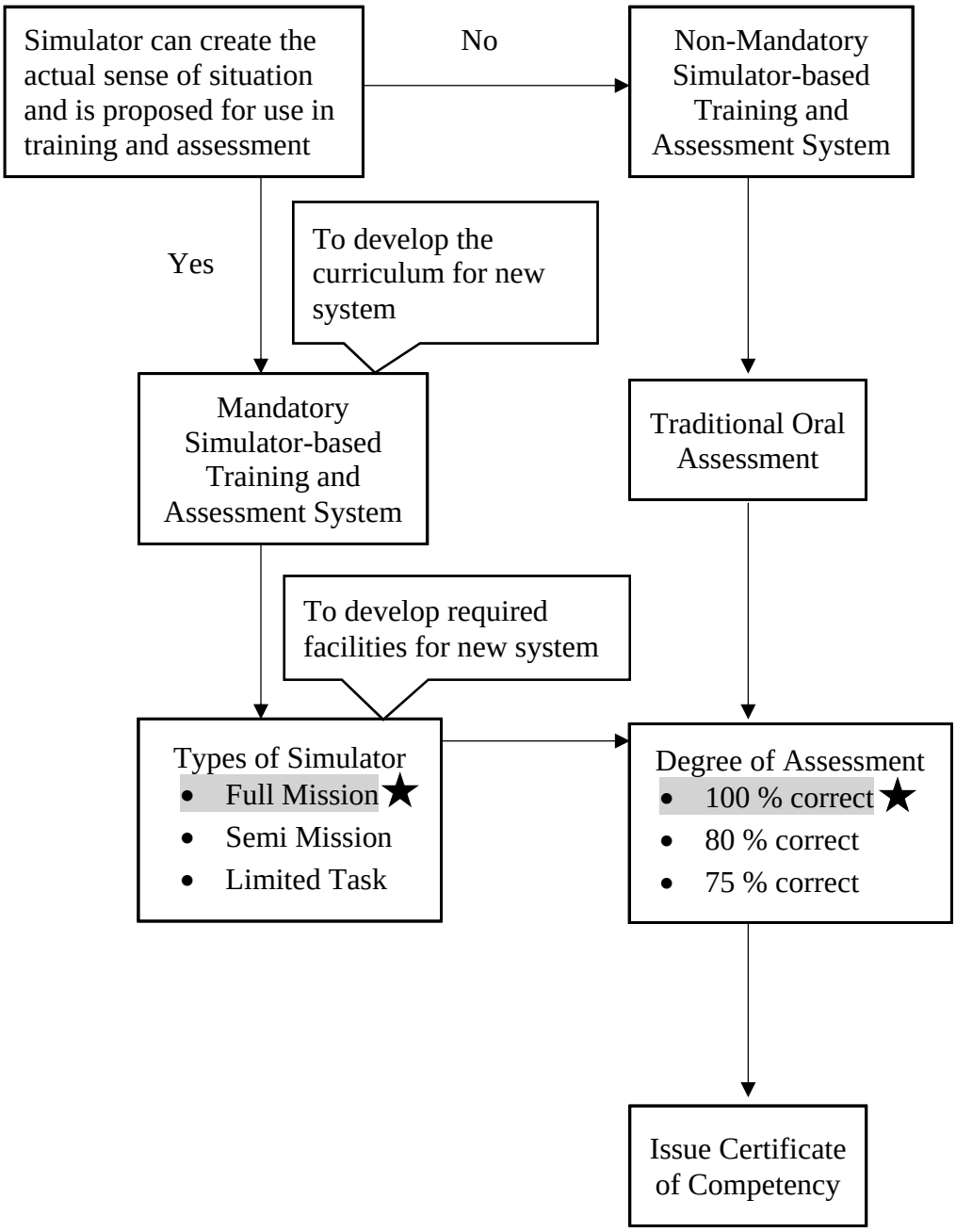

Figure 12 Flowchart for the Research Findings

6. Discussion and Preparation for New Training and Assessment Scheme

6.1. Introduction

This Chapter of the research will explore how simulator-based training and assessment can be provided in the current MET and examination system of Myanmar. It will include a discussion based on the research findings, planning, preparation and development for the new training and assessment system. The researcher has analysed the usefulness and benefits of simulator-based training and assessment in this paper and this section will focus on the discussion of the advantages of simulators. The current training and assessment system of the country has been shown in the Chapter 4.1 and Figure 13 illustrates a proposal for how simulators can be used for the purpose of training and assessment.

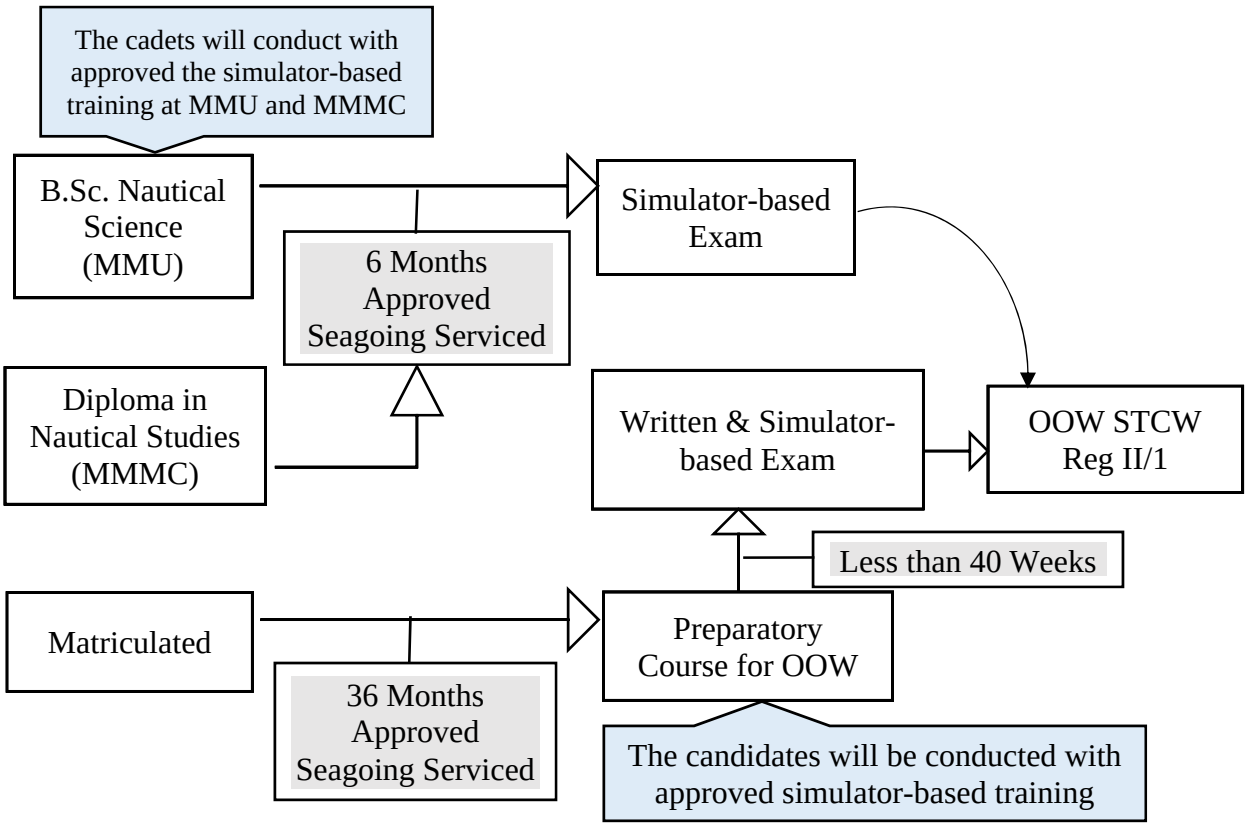

Figure 13 New Training and Assessment System for OOW

6.2. Proposal for Approved Seagoing Service Requirement

The recent requirement of approved seagoing service in Myanmar for the certificates of competency for deck officers in compliance with STCW Reg II/1 has been described in Chapter 4 of the paper. This section will discuss how the required minimum seagoing service can be reduced with the development of a new simulator-based training and assessment system.

However, the development of a new simulator-based training and assessment system for candidates of OOW is needed to meet the minimum requirements and standards of the STCW Convention Reg II/1 and section A-II/1 of the Code. The Convention states the minimum requirement for certification of OOW on ships of 500 GT or more as follows (STCW,1978);

Every candidate for certification shall:

6.2.1. have **approved seagoing service** of not less than 12 months as part of an approved training programme which include onboard training that meets the requirements of section A-II/1 of the STCW code and is documented in an approved training record book, or otherwise have approved seagoing service of not less than 36 months;

6.2.2. have performed, during the required seagoing service, **bridge watchkeeping duties** under the supervision of the master or a qualified officer for a period of not less than 6 months;

6.2.3. have completed approved education and training and meet **the standard of competence** specified in section A-II/1 of the STCW Code.

Firstly, for the students from MMU and MMMC, they have finished their training courses as required by section A-II/1 of the STCW Code before taking the necessary seagoing service. It is possible to reduce actual seagoing service by up to 6 months if they have conducted the approved training programme with simulators at the training institutions. For the purpose of paragraph 6.2.1, this approved training programme

shall be regarded as approved seagoing service for a period of 6 months. However, during the whole period of actual seagoing service, they need to perform bridge watchkeeping service as mentioned in paragraph 6.2.2 and the record of training for their performance needs to be present for the simulator-based examination.

The candidates for OOW certification, other than from MMU or MMMC, still need to perform not less than 36 months of approved seagoing service. After completion of the required approved seagoing service, they have to conduct the preparatory course to meet the minimum requirement of section A-II/1 of the STCW Code for 40 weeks. However, the training period of 40 weeks can be reduced by the introduction of full mission bridge simulator training. They can save their time for unnecessary training periods in order to sit the written and simulator-based examination. Finally, all candidates shall be able to obtain their certificates for OOW in a relatively short period of training time.

6.3. Proposal for Simulator-based Training

The detailed curriculum for the new training system will be prepared according to the research questionnaires and findings. This proposed curriculum will fulfil the requirement of research's requirements and objectives described in Chapter 1 of the paper. The development of the proposed curriculum is aimed to reduce unnecessary teaching hours for deck officer competency training by combining separated subjects into one consolidated curriculum. It will also enable seafarers to be more proficient and skilful in their respective responsibilities and performances.

6.3.1. Purpose of the Curriculum

The main purpose of the curriculum development is to assist the maritime training institutes and their teaching staff in organizing and introducing a new training course or in enhancing, updating or supplementing existing training programmes, whereby

the quality and effectiveness of the training course may be improved[6]. This curriculum shall be used as the teaching guidance for all maritime institutions in order to develop their individual simulator-based training courses for deck officers' competency. The curriculum is also aimed to meet the mandatory minimum requirement of the navigational function under the STCW Convention for various levels of responsibility.

6.3.2. Curriculum Objectives

This curriculum comprises navigational function for all deck officers. On successful completion of the training and assessment, the trainees should be competent to carry out their navigational duties as an Officer of the Watch without any supervision of the other personnel onboard the ship.

6.3.3. Course Certificate

After successful completion of the training and assessment, a document shall be issued to the candidate certifying that a course of training which meets the required knowledge and competence specified in the relevant table of the STCW Code according to the level of examination – operational or management level.

6.3.4. Teaching Facilities and equipment

A classroom equipped with multimedia equipment and whiteboard should be provided for teaching theories of the training course. A full-mission bridge simulator shall be needed to conduct practical navigation trainings and exercises. The navigation bridge simulator should be able to be monitored from a separate instructors' room with several computer screens that show the performance of the students' work. The students should also be provided with a set of required textbooks for guidance relating to the bridge watchkeeping, the COLREGs guide, and general ship knowledge.

[6] The purpose of the curriculum should be needed to align with the IMO's requirement of developing training courses.

6.3.5. General Curriculum Outline

The curriculum is mainly focused on the group of deck officers who are becoming to perform a safe navigational watch after completion of the training and assessment. Generally, the outline of the training course shall be aligned with the elements for assessment, which are prescribed in Table 5. Most of the different subjects such as practical navigation, chart work, COLREGs and passage planning are to be included in the combined curriculum for simulator-based training.

The curriculum will consist of both theoretical and practical learning activities. The theoretical lectures will focus on the familiarization of navigational equipment and its proper usage, planning and maintaining a safe navigational watch, the concept of communication between vessels and shore-based operators, and the understanding of COLREGs. The practical exercise comprises four main scenarios: planning the passage, manoeuvring the ship, taking collision avoidance actions, encountering emergencies and using the buoyage system. Every individual navigational scenario should be designed to use all navigational equipment such as Radar, ARPA, GMDSS, AIS and other navigational aids in order to improve knowledge obtained from the theoretical lectures. The lesson plans with required teaching hours will be detailed in the curriculum for all levels of responsibility according to the mandatory requirements and competence of the STCW Convention.

6.4. Proposal for New Simulator-based Assessment

According to the respondents, the mandatory simulator-based assessment will be conducted to ensure competency for the collision avoidance rules from COLREG and the use of general buoyage systems as required by the IALA. The assessment system shall be mainly focused on maintaining a safe navigational watch for deck watchkeeping officers. It will include the integrated exercises and scenarios for the

preparation of passage planning, maintaining the ship safely in any condition of traffic and visibility, responding to navigational emergencies, including the distress situation, and the actions required to avoid collisions in compliance with Part- B, Section (II) and (III) of the COLREG[7]. These are the four main categories for the assessment of competency in the examination. The candidates are assumed to be qualified for the required competency when they pass these test exercises with the result of 100 % correct and no errors. The contents of the test exercise will vary depending on the level of responsibility, certificates and rank of candidates.

Table 5 shows the detailed elements of the simulator-based assessment, which shall meet the requirements of the STCW Convention.

Table 5 The Assessment Table

No	Competence	Task (Test exercise)	Evaluation	Remark
1	Passage Planning	To plan the navigational schedule and voyage info taking into account the type of own ship, weather conditions and ocean currents, waypoints, no go areas, ETA, tidal streams, arrival and departure port information.	The capacity and procedure for gathering required information for the passage and ability to prepare a detailed navigational plan.	
2	Manoeuvre the ship	To maintain the correct course line throughout the voyage considering the effect of wind, current, sea	The ability to control the ship's speed, course and position by using the helm, rudder and main engine.	

[7] Part B – Steering and Sailing Rules
Section II – Conduct of Vessels in Sight of One Another
Section III – Conduct of Vessels in Restricted Visibility

		conditions, density of traffic and navigational hazards.		
3	Positioning	To acquire the ship's position by means of celestial and terrestrial methods, fix the position and find the DR, EP and ETA for alteration point. To counter check the GPS position with conspicuous landmarks.	The ability to obtain the position with visual observations or aids of GPS, Radar and celestial objects. The ability to choose the correct methods of acquiring position based on the location of the ship (open sea or congested waters with high traffic density).	
4	Look out	To maintain a proper lookout as per COLREGs Rule (5) and STCW Convention Chapter (8) and subsequent actions to be taken in the open sea, restricted visibility and congested waters with high traffic density.	The ability to use suitable navigation equipment such as Binoculars, Radar, VHF and AIS to perform lookout duties by sight and hearing as well as by all available means as per COLREGs. The ability to decide whether risk of collision exists or not by considering the direction, distance and speed of the specific target.	
5	Communication	To maintain a continuous radio communication during the navigational watch by VHF, MF/HF and other sources of	The ability to communicate with proper equipment, exchange information with either other ship or shore, use	

		communication and response for a necessary conversation.	of maritime English with proper terms. The ability to use the INTERCO, including radio and visual signals and the exhibition of signal flags properly and correctly.	
6	Navigational Equipment	To determine the risk of collision by using the relevant navigational equipment on the bridge.	The ability to operate the navigational equipment systematically and properly in accordance with the situations.	
7	Emergency	To determine the cause of an emergency incident and perform necessary reaction in order to maintain the safety of the navigation in any condition of traffic.	The ability to respond to the emergency with confidence, follow the contingency procedure, minimize the loss of ship's property and marine environment.	
8	Distress	To assist the distress situation during the voyage.	The ability to decide to assist the distress taking into account own ship's nature and safety, proper use of communication among the distress vessel and shore-based MRCC.	For Mate Master Candidate (STCW Reg II/2)
9	Collision Avoidance Rules	To take collision avoidance actions with other vessels in the open sea, restricted visibility and territorial	The ability to assess the risk of collision and make a decision to perform the correct action in accordance with COLREGs in the	

		waters including, TSS and narrow channel.	particular situation such as Head-on, Crossing or Overtaking with other vessels. The ability to communicate with another vessel in collision avoidance situation prior to take the action. The ability to take action in ample time with necessary caution until the other vessel is finally passed and clear.	
10	IALA Buoyage System	To navigate properly within the buoyage channel when the ship is approaching the harbour or anchorage.	The ability to use the correct channel taking into account the current draft, loaded cargo, and the size of the ship. The understanding of the nature, characteristics and signal of the buoys whether by day or by night.	

6.5. Summary and Discussion

From the research findings, the development of a new simulator-based training and assessment system can obtain a result with many advantages for the maritime education and training system in Myanmar. The students can get remission either for their seagoing service or training duration by simulator-based training. The simulators will also provide for their required practical training and knowledge. In addition, the simulators can be used to prepare trainees to handle unpredictable or safety-critical

tasks that may be inappropriate to practice (De Winter, Van Leeuwen & Happee, 2012). The trainee can encounter dangerous situations and conditions without being physically at risk and can obtain practical experience from the exercises. Nowadays, all over the world, simulators serve as useful tools for various training purposes to assist the realistic cognitive development of the individual for team collaboration. (Dahlstrom, Dekker, Van Winsen & Nyce, 2009). The well-programmed simulator can also provide a more exact assessment of the candidates relating to their reactions and performances during the examination.

However, it is important to critically examine some of the weaknesses regarding the use simulators as training and assessment tools as well. Unexpected danger situations cannot always be created within the simulator training. For example, while taking the actual collision avoidance action with another vessel, the sudden change of wind and/or current condition cannot be known and programmed as in a simulator exercise. It can be the result of the different consequences and actions compared to the simulator scenario. The graphic displays of limited-fidelity simulators may demotivate the candidates to carry out the performance as in the actual situation during the exercises.

Another important factor to be considered for the use of simulators in the training and assessment process is simulator sickness. The most common effect of simulator sickness is similar to the symptoms of motion sickness such as general discomfort, drowsiness, pallor, sweating, nausea, and vomiting (Kolasinski, 1995). Simulator sickness symptoms may occur with some students, which will put them in an uncomfortable condition and undermine training effectiveness (De Winter, et al., 2012). Familiarization with the simulator may also play an important role for the student in the process of training and assessment. The students need to familiarize themselves with the particular simulator before taking the exam. There may be other kinds of weakness and disadvantages relating to simulator-based training and assessment systems such as the high cost of construction, limited number of trainees, and need for trained instructors and/or necessary equipment (Yordan, 2017). It is

important to define all possible weaknesses and prepare for the solutions in order to achieve an excellent system for the future of maritime education and training in Myanmar.

Generally, simulators can be regarded as essential tools for the improvement of particular training and assessment purposes providing the transfer of necessary knowledge into practical professional careers.

7. Conclusions

The STCW convention prescribes that the qualification of the professional seafarer requires the demonstration of necessary competency in the respective areas. A training and assessment system with simulators has become a mandatory requirement for some of the training courses under the STCW Convention. Many countries have widely used maritime simulators for the purpose of training and assessment. In this case, simulators can be assumed as an excellent means to demonstrate and evaluate the competency of seafarers as required by the convention. However, the method of training and assessment with simulators may be more difficult than the traditional methods for the students. A high level of familiarization with the equipment and system is required before engaging with simulators for training and assessment purposes. The traditional written and oral exams can potentially be passed without understanding the basic practical action. However, within assessment by the simulator-based system, it is not possible to succeed if the students do not have sufficient training, knowledge and skills for the particular assignment. The simulator-based training and assessment system can provide the students with the close proximity of practical duties and actions onboard the ship.

The new simulator-based training and assessment system can be improved by continuous review and monitoring of every stage of the process. It will also be necessary to analyse the feedback and suggestions from the end users such as students, instructors and assessors. The results of the new training and assessment system will need to be compared with those of the previous traditional system. This comparison of the outcomes will cover not only the results of the exam but also the performance of duties and tasks onboard the ships after the students have finished their necessary training and assessment processes. It will also include the analysis of maritime accidents in terms of the extent to which accidents involving Myanmar's Seafarers is reduced after the introduction of new technology in the training and assessment system.

Within the scope of this dissertation, the advantages and benefits of using simulators in the maritime training and assessment system have been identified as a first step. However, the process of implementation is necessary in order to develop the new system for training and assessing for certificates of competency in Myanmar. The implementation process should be commenced initially as a pilot project for the candidates of OOW in navigational function[8]. Subsequently, the outcomes or results can be compared with the previous records. Based on the analysis of the outcomes and results, a simulator-based training and assessment scheme shall be developed as mandatory in Myanmar's MET system.

It is necessary to take into account every force that will resist or drive the change brought on by the new simulator-based training and assessment system. The solution for the resistant forces shall draw upon considerations such as "Why they do not want to change?" or "What is holding the system back?" and prepare for the long-term planning in order to fix the problems of resistance to the new system. The driving forces for changing the new system can be defined with the power and interest of stakeholders as shown in Figure 14.

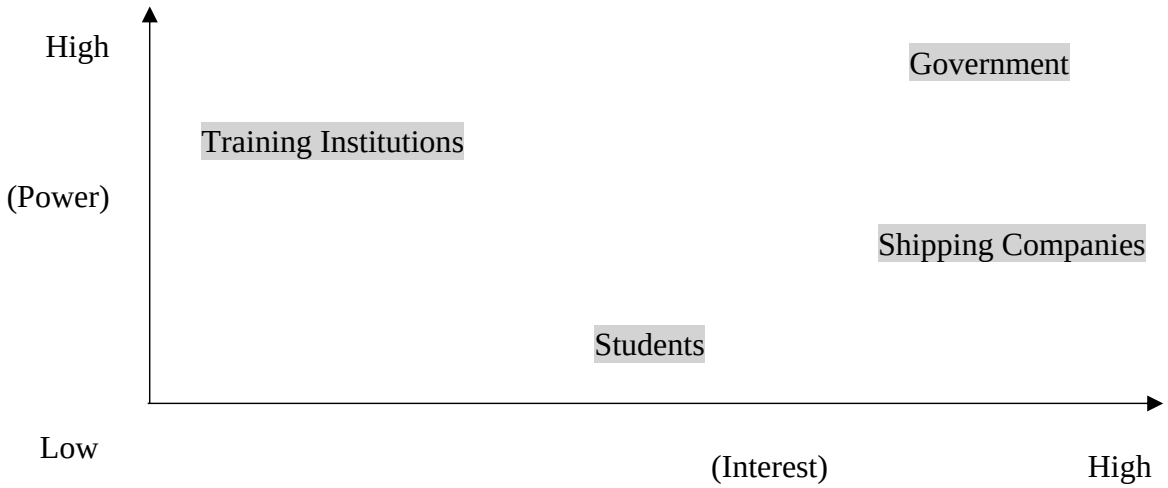

Figure 14 Analysis of Change Driving Forces

[8] In accordance with the requirement of STCW Reg II/1 and relevant section A II/1 of the Code.

The DMA under the supervision of the Government will be the main driving force to implement the new training and assessment system. However, it will require the involvement and assistance of maritime training institutions, students, and the shipping companies for effective implementation. The shipping companies may have a great interest in the new system, as they will obtain qualified seafarers for their necessary shipping operations. The perceptions of the students will be neutral. Even though they have some interest in the new training and assessment system, they have less power in respect of its implementation. One of the main important stakeholders will be the training institutions for developing the new system. However, there will be some restrained forces as the discussions from the previous sections of the research. They have high power with relatively less interest in the implementation. In order to develop the new training and assessment system, the Government needs to realize the driving as well as the resistance forces and exploit the available resources in the correct time and place.

Based on the research findings and analysis, a new simulator-based training and assessment scheme should be needed to develop in Myanmar's MET system. The new simulator-based training and assessment scheme can provide the required standards for seafarers' competency according to the STCW Convention. The practical knowledge, skills and situational awareness of the Myanmar seafarers can be promoted with the use of simulator-based training to perform their related onboard duties effectively. It can also reduce unnecessary seagoing service, training and examination procedures for seafarers according to the research analysis. The simulator-based exam can reduce the excess workload of examiners and assessors. Moreover, the new simulator-based training and assessment system can meet the improvement of new technology trends in the maritime industry.

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Appendices

Appendix 1 – Consent Form

Dear Participant,

Thank you for agreeing to participate in this research survey, which is carried out in connection with a Dissertation which will be written by the researcher, in partial fulfilment of the requirements for the degree of Master of Science in Maritime at the World Maritime University in Malmo, Sweden.

The topic of the Dissertation is "*Simulation Training and Assessment System on maritime Education and Training"*.

The information provided by you in this questionnaire will be used for research purposes and the results will form part of a dissertation, which will be published online and made available to the public. Your personal information will not be published. You may withdraw from the research at any time, and your personal data will be immediately deleted.

Anonymised research data will be archived on a secure virtual drive linked to a World Maritime University email address. All the data will be deleted as soon as the degree is awarded.

Your participation in the questionnaires is highly appreciated.

Student's name	Mr. Cho Thet Maung
Specialization	Maritime Education and Training
Email address	W1802990@wmu.se

* * *

I consent to my personal data, as outlined above, being used for this study. I understand that all personal data relating to participants is held and processed in the strictest confidence and will be deleted at the end of the researcher's enrolment.

Name: ……

Signature: ……

Date: ……

Appendix 2 – WMU Research Ethics Committee Protocol

WMU Research Ethics Committee Protocol

Name of principal researcher:	Mr. Cho Thet Maung
Name(s) of any co-researcher(s):	N/A
If applicable, for which degree is each researcher registered?	Master of Science in Maritime Affairs – Specialization (Maritime Education and Training)
Name of supervisor, if any:	Professor Johan Bolmsten
Title of project:	"Simulation Training and Assessment System on Maritime Education and Training ".
Is the research funded externally?	No
If so, by which agency?	N/A
Where will the research be carried out?	Myanmar
How will the participants be recruited?	Persons In charge of MET in International Maritime Administration, Principles and lectures of International METI will be directly contact through questionnaires
How many participants will take part?	Approximately 50 persons
Will they be paid?	No
If so, please supply details:	N/A
How will the research data be collected (by interview, by questionnaires, etc.)?	The researcher will send electronic questionnaires to the organizations.
How will the research data be stored?	On a password-protected Google Drive and USB Stick
How and when will the research data be disposed of?	The information will be destroyed immediately after my graduation in 3rd November 2019.
Is a risk assessment necessary? If so, please attach	No

Signature(s) of Researcher(s): Date:

Signature of Supervisor: Date:

Please attach:

- A copy of the research proposal
- A copy of the consent form to be given to participants

Appendix 3 – Research Questionnaires

Simulator-Based Training and Assessment in Maritime Education and Training

The country named Union of Myanmar is trying to introduce the simulator-based examination for all deck certificates of competency and the relevant simulator training for the examination in the maritime training centres and institutes. Recently, the system of examination for the certificates of competency is the traditional oral exam conducted face to face with the examiners in the exam room. The following research questions will be provided for the changing of new exam system in maritime education and training.

You are invited to participate in these questionnaires and your participation is completely voluntary without any cost. All of your responses will be kept in the confidence and anonymized and you can withdraw your answer at any time. Thank you for your co-operation.

The information provided by you in this questionnaire will be used for research purposes and the results will form part of a dissertation, which will be published online and made available to the public. Your personal information will not be published. You may withdraw from the research at any time, and your personal data will be immediately deleted.

Research Questionnaires

Email Address
……

Name (Optional)
……..

Organization
……..

Years of experience in maritime industry
…….

Occupation
……..

In your opinion, do you believe that maritime simulators can create the real senses of the situation onboard the ship?

(a) Yes
(b) No
(c) Maybe

If your answer is "Yes", how many percentage of real world situation can be covered by the simulators?

……

If your answer is "No" or "Maybe", please give the comment for your answer.

……..

Part (1) Standard of Assessment

The assessment of collision avoidance rules and aids to navigation for all deck certificates of competency should be conducted by

(a) using the simulators
(b) asking the questions verbally in oral examination room
(c) both the simulators and oral questions

Please give the comment for your answer for previous question.

……..

If the simulator-based assessment is used for collision avoidance rules and aids to navigation for all deck certificates of competency, the candidates should be passed when they could make

(a) no errors and 100 % correct answers.
(b) 80 % correct answers
(c) 75 % correct answers

Please give the comment for the percentage of your answer for previous question.

Part (2) Investment for simulator-based training

What types of simulator are required to meet the minimum standards of training and assessment for all deck certificates of competency required by the present STCW Convention?

(a) Full Mission Bridge Simulator
(b) Limited Task Bridge Simulator (Semi Mission)
(c) Single Task Simulator (Computer-based training)

Please give the comment of your answer for previous question.

Do you believe that the current facilities and infrastructures for simulator-based trainings are suitable for MET of seafarers to meet the minimum standard of STCW in your country and how does this establishment provide the MET?

In your opinion, to what extent the simulators could provide the training and assessment of the competency examination for deck officers including masters?

The investment of simulators might be higher in cost, but in your opinion, could the cost of investment be worthy for the maritime industry of the country and why?

Do you have any plan to invest more facilities and infrastructure for simulator-based training for your organization in future and why?

Part (3) Curriculum development

Do you think the simulator training and assessment for the collision avoidance rules and aids to navigation should be mandatory in the curriculum for all deck certificates of competency?

(a) Yes
(b) No
(c) Maybe

Please give the comment of your answer for previous question.

Part (4) New exam system for deck certificates of competency

Do you believe that the assessment time for all deck certificates of competency will be reduced by using the simulators rather than the traditional oral examination?

(a) Yes
(b) No
(c) Maybe

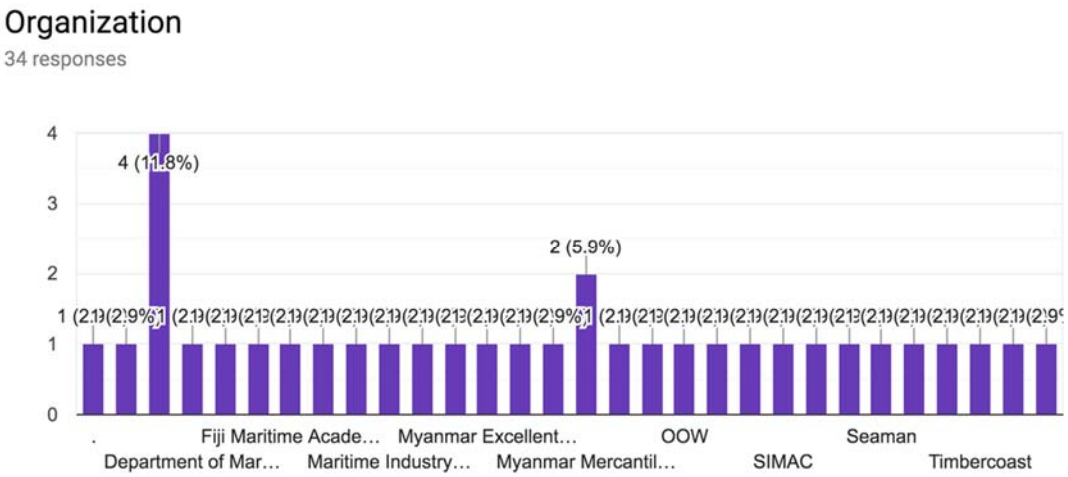
Please give the comment of your answer for previous question.

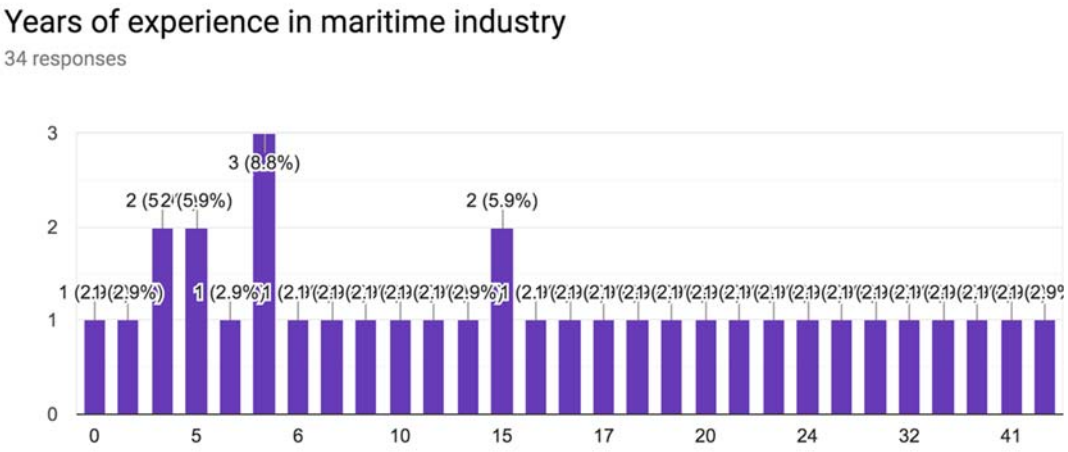
Do you believe that the training time for all deck certificates of competency will be reduced by using simulators rather than full of lectures in the classroom?

(a) Yes
(b) No
(c) Maybe

Please give the comment of your answer for previous question.

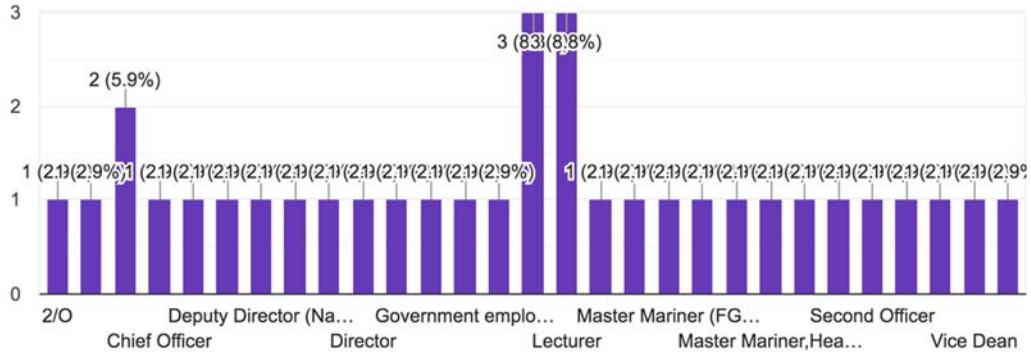
Appendix 4 – Presentation of Questionnaires





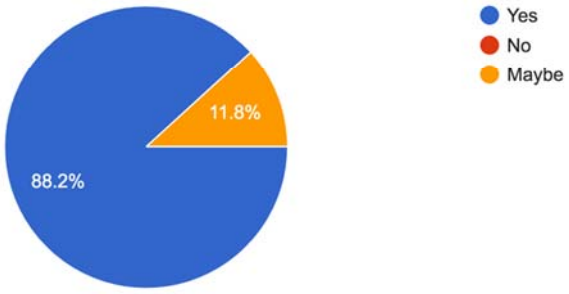
Occupation

34 responses



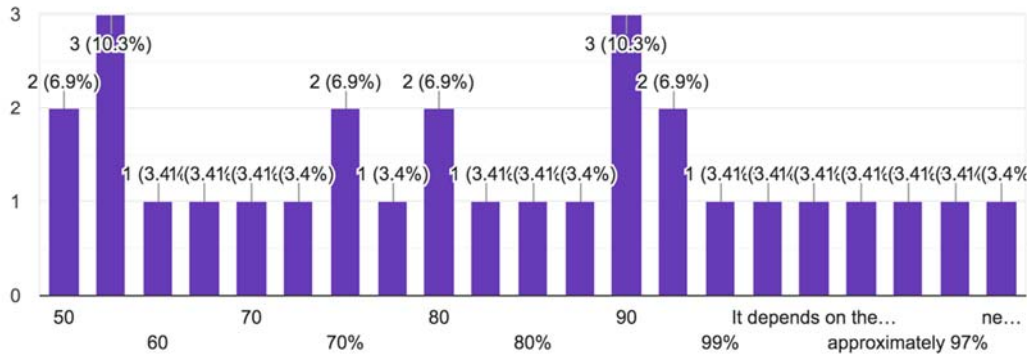
In your opinion, do you believe that maritime simulators can create the real senses of the situation onboard the ship?

34 responses



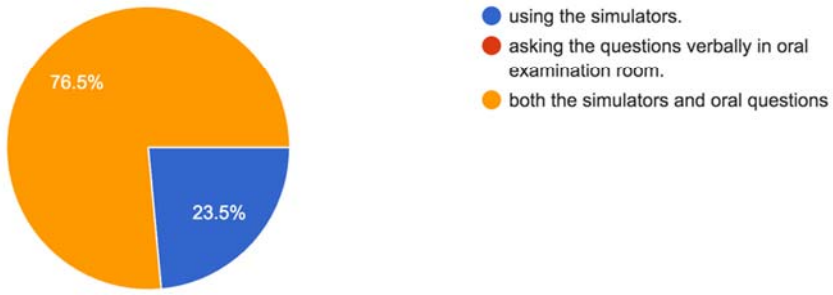
If your answer is "Yes", how many percentage of real world situation can be covered by the simulators?

29 responses



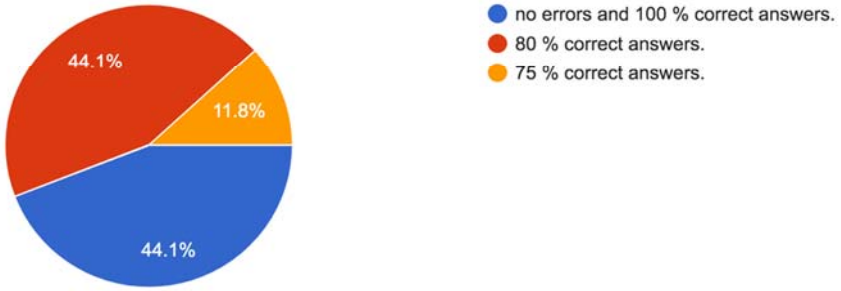
The assessment of collision avoidance rules and aids to navigation for all deck certificates of competency should be conducted by

34 responses



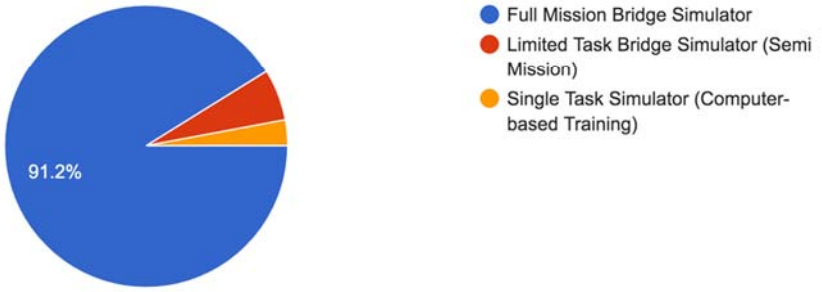
If the simulator-based assessment is used for collision avoidance rules and aids to navigation for all deck certifi... should be passed when they could make

34 responses



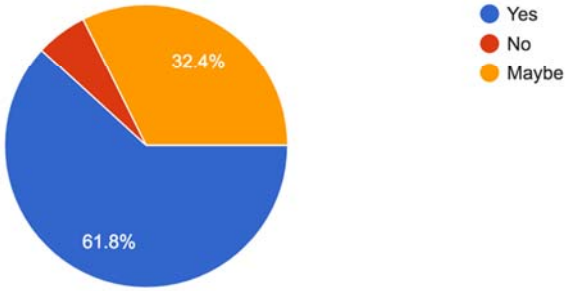
What types of simulator are required to meet the minimum standards of training and assessment for all deck ...uired by the present STCW Convention?

34 responses



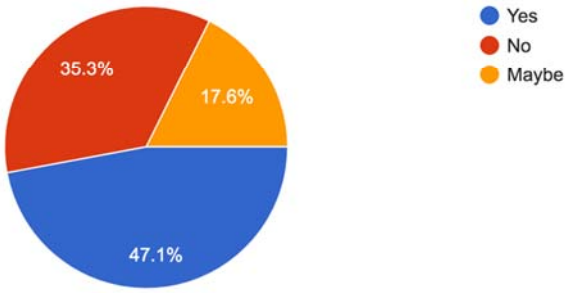
Do you think the simulator training and assessment for the collision avoidance rules and aids to navigation ...r all deck certificates of competency?

34 responses



Do you believe that the assessment time for all deck certificates of competency will be reduced by using th...than the traditional oral examination?

34 responses



Do you believe that the training time for all deck certificates of competency will be reduced by using simulators rat...than full of lectures in the classroom?

34 responses