MBNA Publishing House Constanta 2022

Proceedings of the International Scientific Conference SEA-CONF

SEA-CONF PAPER • OPEN ACCESS

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To cite this article: E. Demirel, T. Albayrak, Proceedings of the International Scientific Conference SEA-CONF 2022, pg. 135-154.

Available online at www.anmb.ro

ISSN: 2457-144X; ISSN-L: 2457-144X

doi: 10.21279/2457-144X-22-017

Evaluation of Simulator Use in Maritime Education and Training (MET) Institutes

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Abstract: Maritime Educationtion and Training (MET) is highly important for seafarers to carry out ship operations and ensure safety at sea. Most vocational courses are conducted in the classroom and simulators to facilitate learning and familiarize cadets with equipment onboard. The simulators are generally used in maritime universities and there are no simulator facilities at shipping companies for except a few companies. A limited number of shipping companies are benefited from the simulators at MET institutes limited with only some training.
This study aims to evaluate the cadets' perception of the simulator applications at MET institutes propose reshaping the use of simulators to achieve better learning for them. The study starts with a literature review of previous studies on simulator training of seafarers and with continues a survey concerning cadets' perception of the application. At the end of the research, the findings will be evaluated and as a result of the study, suggestions will be presented for the planning and execution of the simulator training at the schools.
Keywords: Maritime Education and Training (MET), MET Simulators, Simulator Training, Safety at Sea

1. Introduction

The condition of being shielded from or unlikely to produce danger, risk, or injury is the most common definition of the phrase "safety." In other words, safety is a situation in which threats and conditions that lead to physical injury are regulated to protect people's health and well-being. The notion of safety has developed throughout the ages, and its relevance has shifted dramatically in the latter decades of the twentieth century. Special emphasis was devoted to the perception of maritime and navigational safety around the start of the twentieth century, due to developments in marine shipping and the worldwide environment.

1.1 Safety at Sea

Safety is an important issue in the maritime profession, which ranks second on the list of the most dangerous professions in the world. Human factors, environmental factors, and insufficient education are the factors that cause work accidents. According to studies on the subject, the human factor is responsible for 85% of occupational accidents. The biggest reason for this is seen as a lack of education.

Today, the traffic density on the world's seas is increasing, which makes it necessary to take more serious measures for safety at sea. The most important thing to ensure life safety at sea and to navigate safely is to train conscious and highly trained seafarers. One of the most important assistants in maritime education and training is the use of simulators which provide a real environment.

Simulators are very important to safely experience the events that have happened or can be experienced, observe the mistakes made in the face of these events, compensate for the mistakes, and minimize the undesirable situations that may occur when these problems occur are encountered in real life. Simulators as a part of MET are thought to be particularly useful in minimizing both ship accidents and related lethal results.

1.2. Teamwork at Sea

Maritime is one of the professions where teamwork is most important. Duties at sea are usually done in the form of teamwork. Progress as a team makes work at sea more efficient and sustainable. For this reason, simulators that imitate teamwork more perfectly are gaining importance in the applications made during the MET process.

Simulator applications of the training conducted as a team for ship duties during the school period are very important in terms of familiarizing the students with their sea duties. In particular, pieces of training conducted as a team such as Bridge Team, Engine Room, GMDSS, and ECDIS must be mainly carried out in simulators. Simulator training is low-cost, non-hazardous training. In addition to this, many training organizations accept these simulator training as equivalent to the training conducted onboard the ship.

1.3. Maritime Education and Training

Seafarer training is organized with IMO (International Maritime Organization)'s STCW code (Seafarer's Training, Certification, and Watchkeeping Code. The scope of the education training, skills, competency, and assessment procedures are determined by this code.

Considering rapid development in technology, the new requirements of the maritime industry should be reflected in the maritime education programs. The MET planners should take into account these requirements and evaluate the consistency and efficiency of the syllabus used. To ensure the quality standard in the education system, all respective maritime authorities should provide inputs to MET institutes and academic staff should work on the update of the programs to achieve the inclusion of new requirements and updated information in the syllabuses.

The assessment of graduate employability, sustainability management, and development in maritime research and education requires an integrated approach to anticipate the sustainability of the subjects offered and the impact on socio-economic progress. Primarily, this study examines the main topics and themes in the syllabi of maritime studies, disciplines, and related subjects, which may require revision to raise the graduates' quality effectively and recommendations to enhance the research quality in the maritime domain [1].

1.4. The Role of Simulations in Maritime Education

The real-life threats related to the sea duties could be created through simulation in a safe working environment. This allows the trainees to learn how to behave appropriately when such conditions are created in a simulated scenario. Moreover, learners gain a greater understanding of events and training experiences by experiencing the repercussions of certain actions more efficiently rather than traditional theoretical training, Nowadays the development of students' decision-making and problem-solving abilities are highly important in education, simulator training may also assist students to develop these abilities and skills. Testing and training of the students in some situations may not be practical in a real-world context, as difficulties arise in the real world.

The simulator scenarios based on real events are the key issue to providing a successful training and evaluation. Advanced simulators with a large range of possibilities and technical options can provide a wide range of technological solutions to improve learning efficacy.

For simulator training to be successful, it is necessary to choose the aim and objects correctly and to determine the scenario in a way that supports this. In addition to this, assessment criteria should be determined in a way to cover deficiencies or mistakes. The scope of the simulator scenarios should be based on the theoretical knowledge previously transferred to the student, and the scenarios should be oriented towards real life. Scenarios should be suitable for the level of the student, and the scope and degree of difficulty should be increased depending on the theoretical knowledge given.

2. Research Method

2.1. Aim of the Research

This study aims to evaluate the cadets' perception of the simulator applications at MET institutes and propose reshaping the use of simulators to achieve better learning for them

2.2. Objectives

The objectives of this study are:

- To evaluate the student perspective on existing simulator training

- To evaluate the contribution of simulator pieces of training for cadets

- To make suitable, applicable, and acceptable proposals for simulator training that enhance the knowledge, skills, and competencies of the cadets

2.3. Steps of Study

The study starts with a literature review of previous studies on simulator training of seafarers and continues with a survey concerning cadets' perception of the application. At the end of the research, the findings will be evaluated and as a result of the study, suggestions will be presented for the planning and execution of the simulator training at the schools.

This study may assist MET institutes to define and get benefits from simulators at MET facilities to enhance the knowledge, skills, and competencies of cadets and facilitate their adaptation to sea duties.

3. Research

3.1. STCW and Maritime Safety

The 1978 STCW Convention is known internationally as the first convention to set out basic seafarers' training, certification, and watchkeeping requirements. Before the STCW, similar standards were established by individual governments, often without reference to practices in other countries [2]. It is amended first as STCW 78/95for more clarification and later as STCW 78 (2010) [3] to cover the new regulations and reflect amendments in the existing regulations.

STCW Code has two main parts: Part A of the Rules expresses the obligation to meet minimum requirements and Part B includes expanded recommendations. STCW 78 (2010) Convention aims to provide the international standards required for training institutions and instructors to develop the skills and competencies that are much needed for today's seafarers. The changes made in 2010, on the other hand, are about emphasizing competence. It makes the use of simulators for training in new electronic equipment such as Electronic Chart Display and Information Systems (ECDIS) a mandatory requirement. The use of simulators was introduced not only for training but also for the assessment of competence.

3.2. Simulations

Simulation allows trainers to experience rare real-life dangers associated with their areas of work and thus enhancing a safe working atmosphere. It also enables the trainee to respond correctly when such occurrences happen as they have already experienced it, though in a simulation setup. Going beyond the normal theoretical training and experiencing the consequences of certain acts gives the trainees a better understanding of the situations and training experience. Additionally, simulation helps improve their decision-making and problem-solving skills. The problem of skills is sharpened by exposing them to real problems that require their input to be solved. Testing and training of the crew in certain problems may not be possible real-world setting as when they are in a ship they occur for real, and the survival of the vessel depends on the crews' reactions and actions during the emergency. Therefore, simulation is extremely important.

Even though STCW-95 does not make mandatory simulator training in all instances, simulator-based training is suitable for all the activities being carried out on board. Therefore, subjecting the crew to the simulator training makes all-round individuals who effectively react to many problems facing the ship in case of distress. It is also important in enhancing the ability of the crew members to make the right decisions in high-stress conditions.

Simulation is a technique for practice and learning that can be applied to many different disciplines and trainees. It is a technique (not a technology) to replace and amplify real experiences with guided ones, often "immersive" in nature, that evoke or replicate substantial aspects of the real world in a fully interactive fashion. Simulation-based training techniques, tools, and strategies can be applied in designing structured learning experiences, as well as be used as a measurement tool linked to targeted teamwork competencies and learning objectives [4].

3.2.1. STCW Requirements for a Simulator Based Training

STCW examines simulators in three topics, namely: Training and assessment, Use of a simulator, and Minimum standards of competencies.

Under training simulators and assessment of the seafarers, STCW95 has outlined guidelines using the following regulations:

• Regulation-I/6-Training and Assessment.

• Section A-I/6-Training and Assessment (Mandatory).

• Section B-I/6-Guidance regarding Training and Assessment.

These have been discussed below.

3.2.2. Regulation-I/6-Training and Assessment

Training and assessment Each Party shall ensure that:

Section A-I/6: Training and Assessment (Mandatory) in the STCW states that “This regulation requires that all parties (trainers and trainees) ensure that training, as well as assessment of the seafarers, are done by STCW Code A and that all trainers and instructors are appropriately competent and qualified to carry out their tasks. This section provides guidelines on training using a simulator. According to the section, in case of training is being done or to be done using the simulator, the following guidelines should be adhered to:

• The trainer should take appropriate guidance in instructional techniques including the use of simulators,

• The trainer to have practical operational experience on the particular type of simulator being used for the training.

Additionally, the trainer should have appropriate and sufficient training on the practical assessment of a particular simulator under the supervision of an experienced instructor.

Section B-I/6-Guidance Regarding Training and Assessment

This section gives guidance to comply with Code A. It also gives an explanation of IMO Model Courses for the Instructors as well as seafarers’ training and certification. Under this guidance, there is a special section that gives guidance and regulation on the use of simulators. These have been given under the following topics:

• Regulation-I/12-Use of simulators.

• Section A-I/12-Standards governing the Use of Simulators (Mandatory).

• Section B-I/12-Guidance regarding Use of Simulators

Regulation-I/12-Use of Simulators

This regulation provides necessary guidance for the performance standards of the simulators that are used for training and certification of the seafarers and their compliance with STCW. It covers the following issues: General performance standards, assessment of competence, training objectives, training procedures, and Assessment Procedures. qualifications of instructors and assessors·

Section A-I/12-Standards Governing the Use of Simulators (Mandatory)

This section is divided into two parts: Part 1 and Part 2.

Part 1: This part gives guidance on the performance standards of the simulators that can be used to train seafarers. Under this regulation, STCW requires realism for both behavioral and physical from the simulators for appropriate training and assessment objectives. Additionally, it is required that simulators used for training purposes should be able to simulate unusual, emergency, and hazardous situations to ensure that the training environment is effective.

Part 2: This part offers other guidelines on training and assessment procedures regarding simulator trainers and assessors. Specifically, it requires that simulator assessors and trainers have standard conduct of simulator training. STCW foresees briefing, planning, familiarization, monitoring, and debriefing to be part of any simulator-based exercise. It also shows the importance of guidance and exercise by the instructor during the monitoring and use of the peer assessment technique in the de-briefing stage. Mandatory simulator exercises are defined as; Automatic Radar Plotting Aids (ARPA) and Electronic Chart Display and Information Systems (ECDIS).

Section B-I/12-Standards Regarding the Use of Simulators

This section covers recommended issues for use of simulators in particular for training or assessment of competency. There are detailed guidelines for non-mandatory simulator exercises; Navigation and watchkeeping, Ship handling and Maneuvering, Cargo operation, Radio communications, and Main and auxiliary machinery operation simulators.

3.2.3. Simulator Types accepted by IMO

According to IMO's simulator acceptance, the chosen simulator should be able to adapt to the continuous upgrades of the marine simulators. In this regard, IMO records 4 categories of the simulator: Limited-task, Special-task, Full-mission, and Multi-task simulators

These have been discussed below.

Category I: This category includes full duty (task or mission) simulators. These simulators can provide a simulation of a visual navigation bridge The simulation is also capable of simulating advanced maneuvering as well as offering necessary training on pilotage in restricted waterways. That is, the simulation is capable of simulating the real bridge with its full operations including pilotage.

Category II: This category includes multi-task simulation. Just as in category I (Full mission simulation), this simulation can simulate the full visual navigation bridge. It is, however, not capable of simulating advanced maneuvering in restricted waterways. That is, this simulation is similar to simulation in category except for operations.

Category III: This includes limited simulation: This type of simulator can simulate blind navigation and avoidance of collision. That is, it is mainly used in simulating environments with limited instrumentation.

Category IV: Special Task Simulation: This type of simulation is capable is simulating bridge operations. It is also capable of simulating limited navigation situations. It is, however, important to note that the operator is located out of the simulation environment.

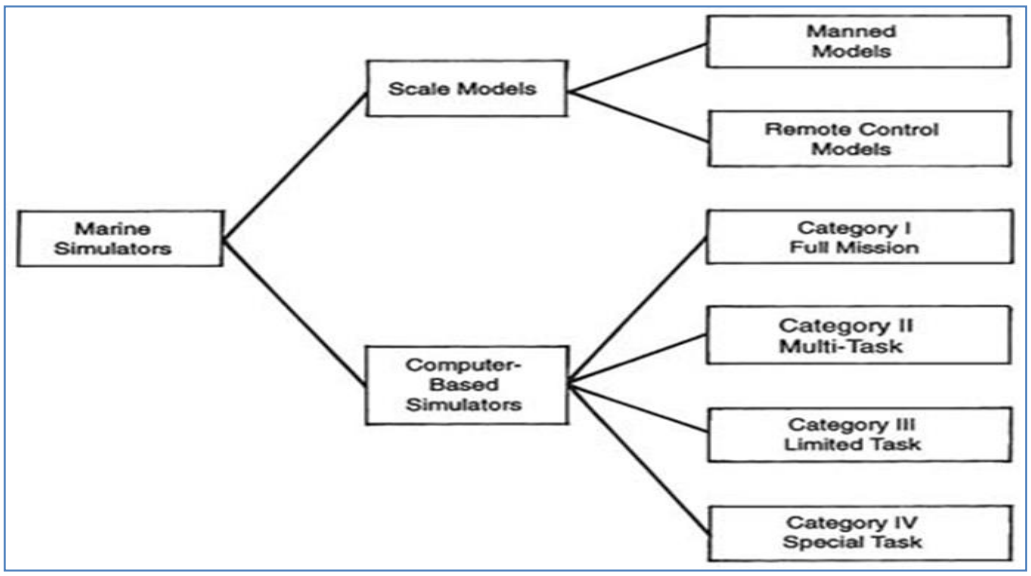


Figure 1: Types of Marine Simulators (Source: Simulated Voyages, 1996 [5])

3.2.4. Simulation Exercises

Training is vital to create permanent high security on board and basic security awareness to protect individuals against possible indifference on the job and increase the motivation of the ship crew [6] SOLAS [7], ISM [8], and ISPS [9] are the major documents that regulate safety at sea, and any change in these regulations should be immediately reflected in MET by the review and revision of education and training methods.

A new type of simulator has been developed especially for this type of training and to ensure safety in general. The conceptual implementation of this improved simulation system, as well as its predecessors, is characterized by 3D visualization design [10]. Recently, such a safety and security training simulator (SST) has been installed in the Marine Simulation Laboratory of the MaRiSa research group at the World Maritime University in Malmö (Sweden) [11].

As a particularly unique feature of WMU's system outlines, SST is integrated with a Ship handling simulator. This resulting configuration allows for a wide variety of simulation applications in BAT, including complex team training for security-related scenarios. In particular, combined simulators are used for research e.g. For a more in-depth examination of the effectiveness of safety and security plans and procedures on board, or for a more comprehensive evaluation and scientific investigation of the effectiveness of simulation trials created individually under different conditions and during various events that may be created, composite simulators are preferred [12].

However, there are more advanced simulators that incorporate various possibilities and techniques. Thanks to these simulators, it is becoming more and more important to deal with the knowledge accumulation processes in general and to ensure effective learning. In this context, the learning environment is fundamentally structured through multimedia, which can be seen as a different and challenging approach to learning, especially when compared to traditional methods. It would therefore be useful and necessary to summarize the main aspects of the relevant infrastructure to describe the design and control functions of any simulation platform [13].

3.2.5. Simulator Training and CBT (Computer Based Training)

The use of computer-based technology in support of training and assessing seafarers is defined as CBT (Computer Based Training). Muirhead [14] explains the importance of CBT “as educational research indicates, learn 20% of what they see, 40% of what they see and hear, and 70% of what they see, hear, and do” [15]. The combination of computers, networks, and multi-media capabilities is a formidable educational tool”.

Especially during the Covid-19 pandemic, distance education with computers has made it easier for both teachers and students to adapt to this type of education. Not only delivery but also assesssessment of courses are conducted by distance learning tools. to create a complete multi-sensory learning program is to allow students to interact with the material, and to learn according to their own needs, pace, and learning styles.

Currently, in addition to simulators in MET organizations, stand-alone computers can also be used as a kind of simulator. Also, some shipping companies apply CBT, which costs less, instead of a simulator. Therefore, it is necessary to evaluate CBT within the scope of the simulator.

3.2.6. Simulator Training Scenarios

The most common method used to develop simulation exercises even today is event-driven. Scenarios of real accidents or near-real accidents, mostly experienced by one of the instructors, reveal what was done or went wrong, and what mistakes occurred. However, such reconstructed scenarios are implemented through discussion to train seafarers on situations to avoid during training. Also, sometimes in the case of engineering, it is expected by seafarers that by identifying a particular defect or defect that led to the development of, for example, a new technical device or another advanced complex safety system, the problem will be resolved, and such accidents will never happen again. Unfortunately, despite new technical systems, new rules and regulations, and increasingly realistic simulation systems, accidents still happen at sea. Because of this situation, it is thought that the event-based design approach to training scenarios is not yet effective enough [11].

Nowadays sophisticated simulators are used in professional and vocational education which are capable of meeting approximately all aspects of the requirements. Baldauf, et al. [6] advise that "event-based scenario design in simulators is at least accompanied or substituted by the learning-objective development of training scenarios. In such a case, the seafarers who receive simulation training will inevitably be much more successful".

3.2.6. Development of Simulators based on Learning Objectives

Studies conducted by various instrumentation experts regarding scenario development for simulator training were examined ([11]; [12], [13: [16], [17]: [18]). resume these studies as four key layers representing the key stages of the scenario development process. Additionally, feedback arrows are also included in the ranking, from educational objectives to general educational objectives and from the sequence of events to educational objectives (See Figure 2).

Figure 2: Principal layers and elements of the scenario development process
(Source: Baldauf et al., 2012) [16]

3.2.6. Developing an Effective Training Program

Observations so far indicate that training on the simulators produces graduates who are more quickly and better able to operate particular mechanisms and acquire a full appreciation of the processes involved. The simulator training also overcomes major drawbacks of on-board training, fault diagnosis, analysis, and rectification [19].

And of course, the consequences of mistakes are substantially reduced. One of the most important aspects of simulation training is how to use simulators and how the training is delivered. Even if the latest simulation technology is adopted and there are no proper training programs put in place, the simulation training may not provide any extra benefit. Therefore, the most important thing in simulation training is assessing whether the simulation training is providing extra benefit or not. An efficient training program takes into consideration students' needs regarding their knowledge and experience. Such training entails all aspects of training from the computer-based training of the personnel to simulation-based training. Simulated Voyages prepared by" Committee on Ship-Bridge Simulation Training" is a pioneer in simulation and is still used by simulator training planners. An example of the simulator training process in this book is shown in Figure 3.

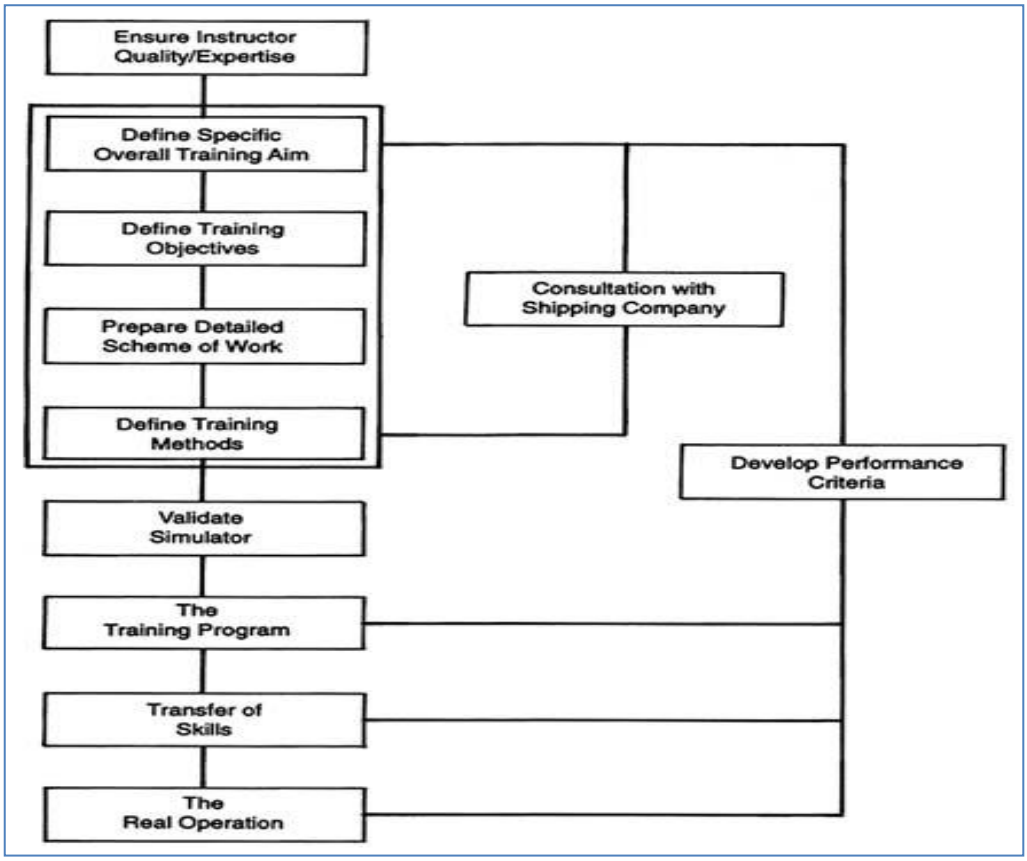


Figure 3: The Training Process Table (Source: Simulated Voyages, 1996) [5])

3.3. The Survey Viewing Students' Perspective on MET.

3.3.1. Preparation for survey

To prepare questionnaires for the survey, a study group was established composed of 7 maritime lecturers having 10-20 years of sea and academic experience. The group has been introduced the updated information about the simulator training of MET based on the literature study. The study group has defined the hypotheses, and subsequently content of the survey questions is settled. Then most suitable focus group is defined. The initial questionnaires are submitted for testing in December 2021. Making some changes in the questionaries final form is defined and University

Ethics Board approval is obtained. After testing the initial questionnaires some changes have been made. The questionnaire has been distributed 4 selected maritime faculty in Turkey

3.3.2. Hypotheses

The following hypotheses are selected.

H1: ***Simulator training is effective to support MET***

H1.1: Some types of simulator training are more effective than others

H1.2: Assigned simulator hours should be rearranged

H1.3: Use of simulators in training is inadequate

H2. ***Delivery of simulator training should be reshaped to improve quality***

H2.1: The preparation phase of simulator training should be improved

H2.2: The debriefings should be reshaped to make the students better understanding of the subject

H2.3: The manning of the cubicles should be optimized for better learning Lessons learned.

H3. ***There are some deficiencies in simulator training that need to be corrected***

H3.1: There are some problems in the manning

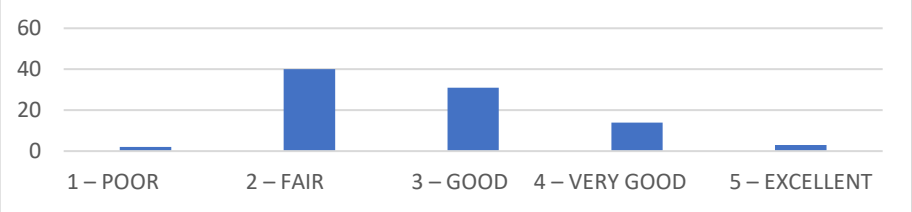
H3.2: The class hours need to be increased for some types of simulator training

3.3.3. Survey participants

The participants were selected from senior cadets, nearly graduated cadets from different nationalities. 90 cadets of various nationalities and from different schools have participated in this survey.

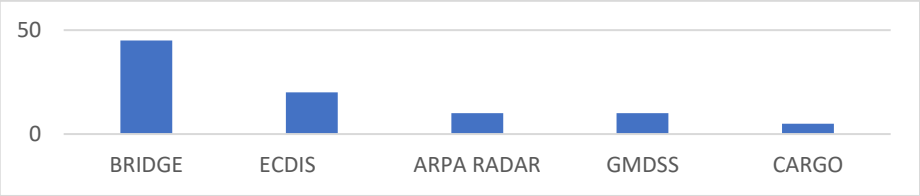
3.3.4. Questionnaires & Analysis of Survey Results

1. At what level do you evaluate the benefit you get from the simulator training?



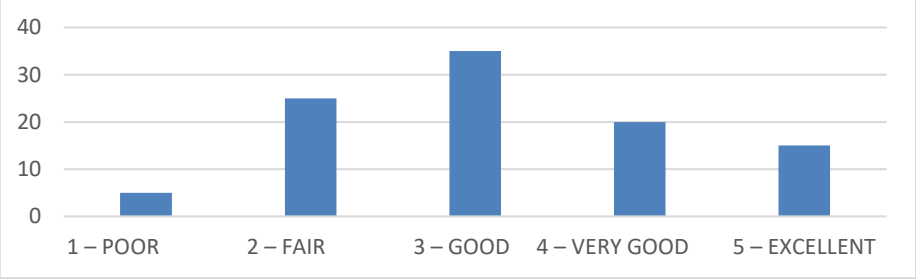
Most of the students stated that they benefitted from the training they received in the simulators. More comprehensive application of a delivery method that students like and attract attention to will increase the learning level.

2. Which simulator training provides more benefits to you?



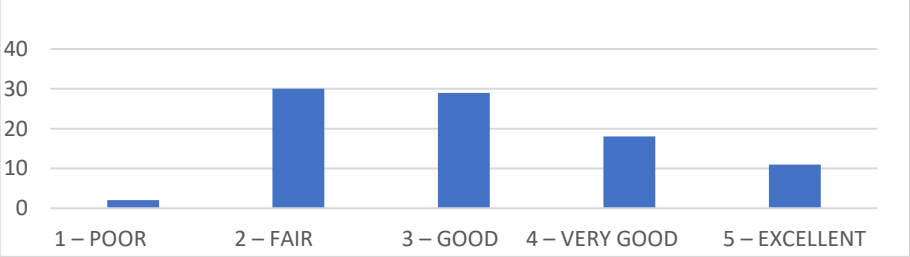
Most students selected the Bridge simulator as the best one. The ECDIS is the second preference. A bridge simulator provides an environment that covers all aspects of navigation and watches applications and where events at sea can be simulated most realistically. The bridge simulator applications should have priority.

3. At what level do you define the benefit of Bridge Simulator?



More than half of the participants defined the benefit of Bridge Simulator as good and very good and one-third states it as fair or poor. The rate of benefiting from the training made in the Bridge simulator is quite high. If the hours are increased and further developed, the opportunity to benefit from this training will also increase.

4. At what level do you define the benefit of the ECDIS Simulator?

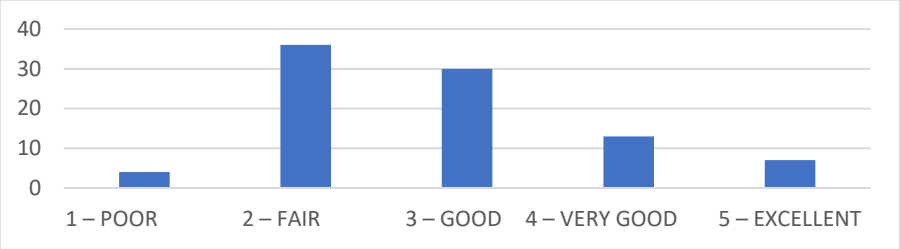


More than half of the participants defined the benefit of the ECDIS Simulator as good, very good, and excellent and one-third stated it as fair or poor. Today, ECDIS is the most important information source on the bridge. A comprehensive ECDIS training will increase the benefit of bridge simulator training.

5. At what level do you define the benefit of the ARPA radar Simulator?

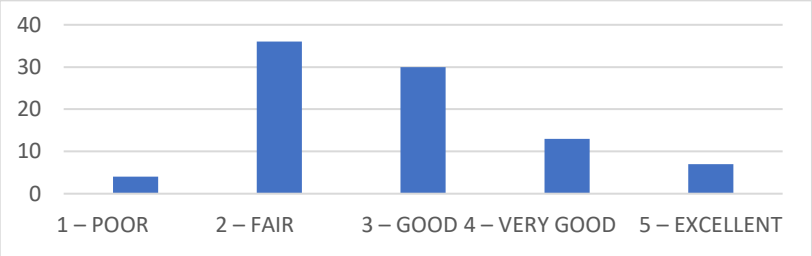
Most of the participants defined the benefit of the ARPA Radar Simulator as good and fair. Like ECDIS, comprehensive ARPA training will increase the benefit of bridge simulator training.

6. At what level do you define the benefit of the GMDSS Simulator?



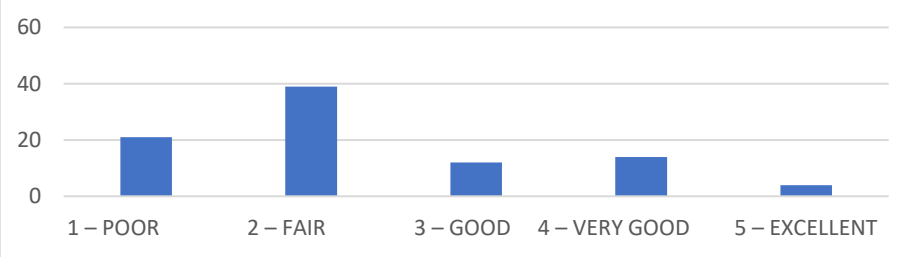
Most of the participants defined the benefit of the GMDSS Simulator as good and fair. GMDSS is of great importance for safety at sea.

7. At what level would you describe the contribution of simulator training to your learning?



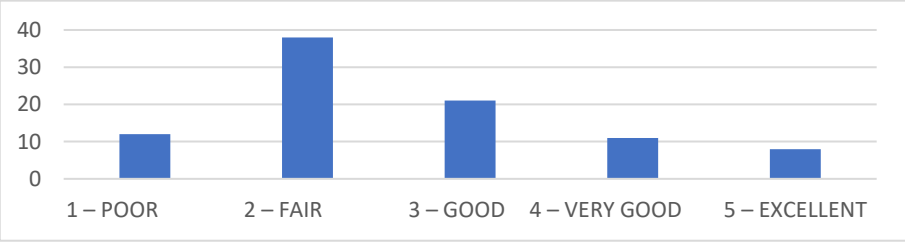
Most of the participants defined the contribution of the simulator training to their learning as good and fair. One of the most important elements in education is to increase the learning level. It is understood that simulators are successful in providing this.

8. At what level do you evaluate the adequacy of the briefing made before the simulator training?



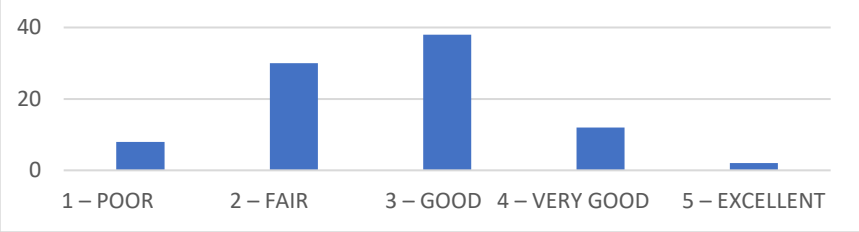
Most of the students assess the adequacy of the briefing made before the simulator training as poor and fair. That means the briefings given before the training are insufficient. This issue should be evaluated as a factor affecting the quality of education negatively.

9. At what level do you evaluate the adequacy of the debriefing at the end of the simulator training?



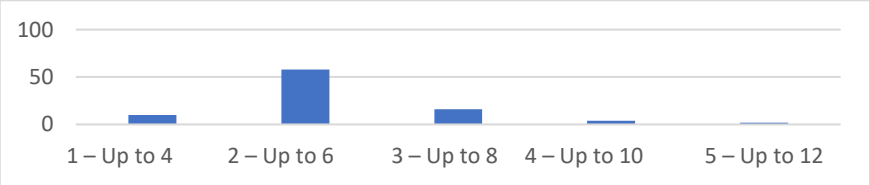
Most of the students assess the adequacy of the debriefing made after the simulator training as poor and fair. That means the debriefings given to the students as an overall assessment of training and underpinning the critical information are insufficient. This issue should be evaluated as a factor affecting the learning level negatively.

10. At what level would you define the reality of the scenarios used in simulator training?



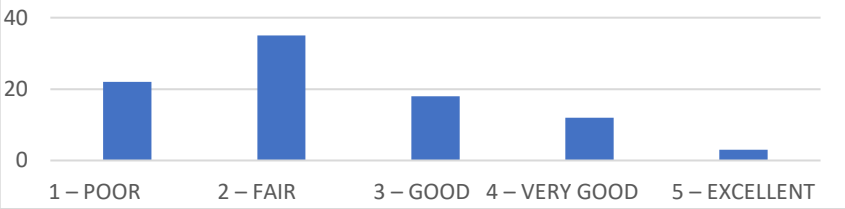
Most of the students assess the reality of scenarios used in the training as suitable.

11. What should be the maximum number of students who can participate in the cubicles?



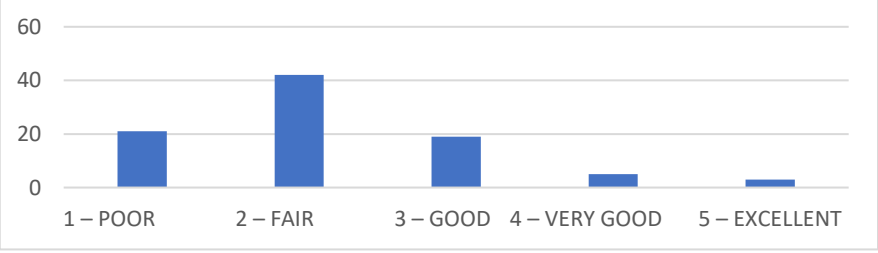
Two-thirds of the students propose that the maximum number of students who can participate in the cubicles should be less than 6. Bridge simulators need to provide better participation for each student in training.

12. How do you evaluate the adequacy of allocated lesson hours for simulator training?



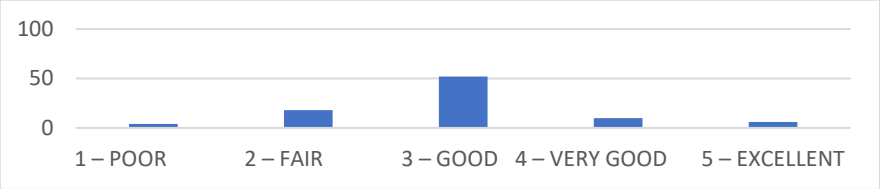
Approximately two-thirds of the students evaluate that allocated lesson hours for simulator training. The class hours allocated for simulators for vocational courses should review and enhanced as much as possible by transferring some allocated hours from conducting in the classroom to simulator training.

13. To what extent does the simulator training contribute to your academic studies?



Approximately two-thirds of the students evaluate the contribution of the simulator training to their academic studies as poor or fair. It would be better to make research on this issue to define the reasons.

14. To what extent do you evaluate that the simulator training prepares you for the sea duties?



Over 80 percent of students describe simulator training as a suitable tool to prepare them for sea duties. The factors that will make students feel ready for the sea are very important psychologically. In this respect, simulator training should be emphasized.

4. Discussions

4.1. Importance of Simulation Training

Due to economic reasons ship owners has no intention to increase the number of crew deployed onboard and ships sail with a sole navigator at the bridge. This situation negatively affects the safe navigation of the ship especially when young and non-experienced officers keep watch solely. There is a strong need to prepare officers of the watch to respond to emergencies at sea. Simulators are the best tools to prepare young officers to be able responding emergencies and improve their decision-making abilities as well as assist in the success of team training.

Simulator training reflecting real situations is important both for maritime safety and for preparing seafaring officers and cadets for sea duties. Thanks to such simulation exercises, students gain experience and know-how to behave in the event of an accident.

Ships are the largest vehicles ever created by humans. Nowadays, ship management systems developed for easy handling of huge vessels are almost fully automated. But any automation failure may cause accidents with damage to human life, the environment, the ship(s), port facilities, and the goods being transported. Due to excess dependence on automated systems, any failure in the propulsion, communication, command control, or cargo handling systems may end up in serious, even fatal accidents. This means is that even the most developed automation systems must have some form of control by the human element at all times which also brings forward another reason for better education and training requirements on these systems for seafarers.

Many pieces of training cannot be conducted on board for safety reasons. But this kind of training can be achieved by simulation training safely and cost-effective. The simulations can be repeated so that every candidate is faced with the same scenario.

In addition to the above-mentioned advantages the simulator training provides the followings:

• The learners can be familiarized and adapted to new technologies

• The training provides confidence to cadets who have previously not experienced different emergencies. They may adapt easily to the environment and react the emergencies

•Simulation training is critical for seafarers because it can help them understand the consequences of actions if they make the wrong decisions. It also helps cadets get real-life experience without endangering the lives of those on board or destroying the ship or exposing the ship to extreme conditions.

• The simulators imitate approximately the real situation at sea. The participants strongly believe that a bridge simulator is the most suitable manner for the preparation of bridge team duties onboard.

• Nowadays the state of arts simulators is very similar for equipment onboard and very suitable for team training onboard. Widespread use of simulators will enable cadets and young officers to familiarize themselves with the devices on their assigned ships. They can adapt more easily to the environment and do not feel humiliated for their lack of experience in front of their colleagues.

4.2. Development in the Simulator technologies

Depending upon the developing technology, simulators with more realistic simulation capabilities are being developed. This will enable us to benefit from simulations more comprehensively. It provides the opportunity to give the lessons that are still given in the classroom, in simulators. To achieve this, it would be appropriate to review our syllabuses and to make training programs with an emphasis on simulator training.

Full-task simulators available in the MET institutes are expensive and require special instructors. Unfortunately, shipping companies have not generally had this kind of high-capacity simulator. They may use low-cost stand-alone computers for simulation purposes and send the crew to simulators at MET institutes to intensify their skill, especially for safety-related training. But most companies have no intention to do that due to economic considerations.

Nowadays newer and various simulation equipment is available in improved MET institutes which facilitate the delivery of knowledge and experiment and increase the effectiveness of the training. High technology allows for creating a virtual reality that enables the creation of real-world situations to be experienced in the simulators. Many types of accidents could be created in the simulation systems as equivalent to real-world conditions without causing any danger and cost. As technology gets better and better in terms of graphics and simulation, the value of simulation-based training will increase. Training made with the high-capacity simulators prepares seafaring officers for emergencies at sea and assists in ensuring safety at sea.

4.3. Design of the Simulator Trainings

Simulator training of seafarers should be designed mainly for potential emergencies at sea. It. The training should also be designed to create situations that could not be conducted onboard due to the risky nature of this training. The learning outcomes of the courses at MET courses would be the best guidance to prepare simulator training to support the student's academic success with simulated real-life conditions. The companies may define their specific requirements fit to their expectations. For this reason, simulator training should be different for the cadets and ships crew.

The key element to starting simulator training is the learning outcomes. The scenario designers should define the aim, objectives, and content of the scenario in light of learning outcomes. Learning outcomes and assessment details could be easily extracted from the respective competency tables of the STCW.

There are no definite standards for the simulator training to be applied in the STCW 78 (2010), IMO Modal Course 7.01., 7.02, 7.92, and 7.04, which cover the basics that determine the scope of MET training in detail about seafaring officers. But unfortunately, there is no clear explanation in this guide books which provides fundamental issues for planning and conducting simulator training. The aim, objectives, content, and application methods for each simulator training should be added to these guidance documents in line with the related competencies and qualifications defined in STCW.

4.4. Delivery of Simulator Training

An important key to the success of training programs is the effectiveness of the relationship between apprentices and instructors. Simulation-based training can better simply the sharing of experience between trainer and candidate by allowing the trainer to enhance their knowledge and permit it in software built from the same acquirement space. Simulators are genuine educational implements as they allow the collaboration of multiple related areas within maritime education to get involved in the use of knowledge to predict reality and create learning equipment that represents it.

A well-designed and delivered simulator training using advanced simulation techniques offers a practical and cost-effective alternative for seafarers to enhance their skills for safe navigation.

Simulation-based training should facilitate the sharing of experience between trainer and learners by allowing the trainer to enhance their knowledge and permit it in software built from the same acquirement space. The instructors who give the training should be familiar with ship equipment on board and related simulators. Simulators are genuine educational implements as they allow combining multiple related subjects within maritime education to get involved in the use of knowledge to predict reality and create learning equipment that represents it.

One of the most important aspects of simulation training is how to use simulators and how the training is delivered. The planners should evaluate if simulation training may not provide any extra benefit or not. Therefore, the most important thing to design the training is to get maximum benefit which could not be provided by the delivery of the course in the classroom. An efficient training program takes into consideration students' needs regarding their knowledge and experience. The training process is shown in Figure 3 is considered a good example for training planners.

4.5. Assessment of Questionnaires

All following hypotheses of the survey are proved.

H1: Simulator training is effective to support MET
H2. Delivery of simulator training should be reshaped to improve quality
H3. There are some deficiencies in simulator training that need to be corrected
Additionally.

Some types of simulator training are more effective than others. It is understood that the students get more benefits from the bridge and ECDIS simulators.

The existing application of simulators training is not exactly adequate and needs to be revised. There is a strong need to increase assigned simulator hours to get more benefits.

The preparation phase of simulator training is important to prepare students for the scenario and draw attention to the aim and objectives of the training. It şs understood that briefings are not sufficient and should be improved.

The debriefings are important to evaluate the results of training. It should cover critical issues to make the students better understand the lessons learned and corrective actions.

The manning of the cubicles should be optimized for providing better participation of the students in the training. It is very important for manning Bridge Simulators and an optimum number of participants in a cubicle should be a maximum of 6 students.

The assigned simulator hours should be increased to provide a better understanding of the course subject.

5. Conclusion

An important key to the success of training programs is the effectiveness of the relationship between learners and instructors. Simulation-based training can better simplify the sharing of experience between trainer and candidate by allowing the trainer to enhance their knowledge and permit it in software built from the same acquirement space. Simulators are genuine educational implements as they allow the collaboration of multiple related areas within maritime education to get involved in the use of knowledge to predict reality and create learning equipment that represents it. The instructors who give the training should be familiar with ship equipment on board and related simulators. Therefore, universities should organize simulator seminars primarily for lecturers.

The seafaring officers should be made more competent and skilled in their responsibilities and performance. The curriculum should also aim to meet the mandatory minimum requirement of the navigational function under the STCW Convention for the various levels of responsibility. The curriculum should be used as a teaching guide for all maritime institutions to develop individual simulator-based training courses for seafarers' competency, and the development of the proposed curriculum should combine separate subjects into one consolidated curriculum, balancing classroom and simulator hours.

MET institutes begin to implement newer and various simulation equipment which enhance the effectiveness of delivery methods. As technology gets better and better in terms of graphics and simulation, the value of simulation-based training will increase as virtual reality gets closer to real situations. Training made with the simulation method is also important in terms of safety at sea. Applications that can cause serious accidents and damage in the real world can be easily implemented in simulation systems without causing any danger and cost.

The development of Maritime simulation has partly been supported by its acceptance by STCW regulations and other maritime authorities in the position of sea-based training time. Since simulation training can be more effective through its use of structured scenarios, it has gained approval as a superior form of training, which has led to its growth in many maritime training institutions which seek to train students to updated standards. Training facilities, which can save time and money by avoiding longer sea time, are encouraged to implement simulation-based training. While the use of advanced simulators that simulate the real situation will increase the quality of education in schools, it will also shorten the 12-month mandatory sea training period allocated for sea training.

Researchers working on the use of simulators for MET have agreed on the following issues.

• Although it is aimed to develop simulator training with STCW 78 (2010), there are no definite standards for this issue. There is no clarity on this subject in IMO Modal Course 7.01., 7.02, 7.92, and 7.04, which cover the basics that determine the scope of MET training in detail about seafaring officers. It is beneficial to prepare the aim, objectives, content, and application methods of simulator training for each subject related to the competencies and qualifications of OOWs in addition to the training documents in question.

• The main purpose of the simulator training is to enable the students to learn better by actually applying the information they have learned in the vocational courses in the virtual environment, and thus to prepare them perfectly for the sea missions. The important word here is “learning”. For this purpose, the aims of the simulator training should be determined according to the learning outcomes.

• Simulator training should be prepared in real conditions, not artificial. This can be achieved by examining real events at sea, especially investigating accidents reports. In addition, it is essential to plan the training according to certain principles and be open to continuous improvement.

• The success of simulator training is directly related to how the application is made. This depends on the skills of the simulator trainers. Large-scale simulator centers have been established in advanced MET institutions and are equipped with trainers who only provide training on this subject. A similar practice in other MET institutions will increase the quality and efficiency of simulator training.

Regarding the use of simulators for MET, the following findings and results were obtained from the survey applied to the senior cadets.

• Cadets have a positive attitude towards the necessity and progress of simulator training. The cadets' positive view of simulator training is a valuable factor for the success of that type of education. It requires them to care more about the simulator training, which should be considered when preparing training programs.

• Cadets value bridge simulator training the most. A simple basis for this is the students’ interest in bridge applications and the ability to adapt to these tasks in a shorter time. Secondly, they are interested in ECDIS simulators. The charts are the essential element for safe navigation and ECDIS replaced the printed charts. ECDIS is directly related to planning and conduct of passage planning and facilitates OOW functions at the bridge. These two types of simulator training directly increase the quality ad success of essential courses such as Navigation, Navigation Watch, and Ship Handling.

• They do not find the pre-training briefings sufficient. The cadets should be fully infirmed about the use of the simulator system, the aims, and objectives of training before they commence training. A sufficient time covering all necessary information should be assigned before the start of training.

• Cadets also find debriefings after the training insufficient. It is not possible to accept an education that is not evaluated. Especially at the end of the simulator training, the explanation of the mistakes in the figures and movies is very important for the trainees to understand and accept the mistakes. An excellent evaluation at the end of the training will ensure that subsequent training is also successful.

• Cadets especially desire to limit the number of participants in their training in cubicles. In an education attended by a large number of students, some students cannot focus on any task, and the

presence of a large number of students in a narrow space negatively affects the success of the education. For this purpose, the optimum number of participants should be determined by considering the real number of personnel in the bridge team and the tasks and available assets in that cubicle.

• Cadets also find the time allocated to simulator training insufficient. It is necessary to evaluate the positive approach of students to simulator training. For this reason, education planners should work on which parts of the classroom training they can shift to simulators and adjust their delivery methods accordingly.

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