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Contents

Smart Ports

Ports were described by several names and titles. In terms of size there are small, medium, Large and mega ports, in term of ages, they were specifies as old, modern or new ports. In terms of generation, they have named themselves accordingly first, second, third and the fourth Generation. For the goods operation there are central port, and Hub ports and so on it is endless chain of names aiming at obtaining a market place in the expanded maritime transportation. Smart ports, intelligent ports and Information ports are the new version of theadvertising of thisnonstop progress. However, smart ports have received a sound acceptance in the freight business; leading ports such as Rotterdam, Singapore and Vancouver have already declared themselves as Smart Ports.

Smart ports necessitate that every single component in the port operation to be functioning in smart way. Smartness may be defined that a processes of less paper, time, effort, manpower and less cost and with maximum turnover and benefits. Increasing the gap between the lessees and the maximums denotes the smartness of the port.

Monitoring and tracking systems in smart ports add to the smart operation. Efficient tracking system help the management tolocate the position of every single mobile target in and near by the port. Incoming trucks fitted with smart tracking deviseshelps to allocate proper loading/unloading slots in the port. Port navigation with smart identification system facilitatespiloting, minimize the berthing time and assure the required safety.Smart port is a comprehensive integration of all operation in the port and in its affiliated hinterlands.

The requirements of the smart ports necessitates analytical thoughts tacking into accounts the identification systems operated in the other leading ports and the potential capabilities of the ports in developing countries.The analyticalreview may draw a Road Map for the existing ports to be converted to smart ports in terms of locating the position of vehicles and assure its and improving the traffic management of trucks,and sorting the containers allocation and their security.Virtual aids to navigation and berthing systems also benefit from the identification system based on new technology of GNSS positioning and GSM communication systems provide an essential means to assure safe navigation in ports.

However in order to become a member of exclusive club of the smart ports, the country and the administration, should also move toward the smartness with utmost development of intelligent management and human resources.

Refaat Rashad

Development of Maritime Simulator Training to Enhance Seafarers Competency

Zouheir Badawy - Ayman Salah

AASTMT

المستخلص

لم يعد إستخدام المحاكيات البحرية يقتصر علي المنظمات والأكاديميات البحرية الكبرى، بل إزداد انتشاراً ليضم مراكز التدريب البحرية والمدارس والجامعات وشركات الغاز/البترول وكذلك القطاعات البحرية والعسكرية وحرس الحدود.

تأثرت انواع طرق ووسائل التعليم والتدريب البحري بالاتفاقية الدولية لمستويات التدريب واعمال النوبة STCW وتعديلاتها ٢٠١٠، حيث اوصت بإستخدام المحاكيات البحرية كوسيلة للتدريب والتأهيل البحري وذلك لرفع مستوي كفاءة طاقم السفينة.

تناولت الورقة البحثية أهداف وعناصر واساليب التدريب والتقييم بإستخدام انظمة المحاكيات البحرية طبقاً لإحتياجات التشغيل على السفن ومتطلبات الإتفاقيات الدولية، كما سلطت الضوء علي تطور منظومة المحاكيات البحرية في الأكاديمية العربية للعلوم والتكنولوجيا والنقل البحري.

Abstract

Investment in maritime simulators is no longer limited to just the largest academies and organizations. Today's simulator customers represent a broad mix of different organizations, from public training academies and universities, training centers and vocation schools, to shipping and oil & gas companies; as well as military training organizations including Navies, Coast Guards and Maritime Police.

The Manila 2010 revision of the International maritime Organization (IMO) training convention (Standard of Training Certification, and Watch keeping for Seafarers (STCW) has had a considerable impact on the types and extent of training and education, subsequently on the training equipment used.

As training on maritime simulators become more commonplace and the international requirements will prescribe or strongly recommend simulator training as a means to acquire competence, there will also appear a need to assess this competence. But in order to assess competence the actual training objectives will have to be described and the appropriate training tools be identified.

This study focuses on the training evaluation in maritime domain, discusses the marine simulator training objectives, elements and assessment, highlighting on the development training system in Arab Academy for Science, Technology & Maritime Transport (AASTMT) Simulators.

1. Introduction

The shipping industry consists of a wide variety of shipping business and operations known as "industrial chains". The chains are spreading in the context of globalization of world economy and integrated transportation, and therefore, play more and more important role in the macro economy. As one of the key elements in the chains, seafarers are not only the navigators at sea, but also a very important resource of shipping talents for shore-based shipping operations – in shipping industry, it is widely accepted that shipping-related

Professionals ashore are ideally those with sea-going background.

Seafaring profession is a specialized profession, which has to meet the requirements of both ship owners and international maritime conventions. Furthermore, the requirements for quality seafarers keep updating, because of the advancement of navigational technology, development of maritime administration systems and higher standards in maritime safety, security and marine environment protection. In some respects, such requirements are even higher than those defined by the STCW Convention. Today, ships are becoming bigger, faster and more automatic. Seafarers are required to be more professional and specialized.

Maritime Education and Training (MET) universities and academies should pay special attention to understand that "Quality seafarers" needs to be developed to satisfy the social request for "quality shipping industry". "Quality seafarers" refer to those have good experiences onboard, excellence in seamanship, computer skills, English language, ship management, interpersonal communication, professional virtues and commitment (YU shicheng, 2009). Simulators and Sea training on board a ship plays a key role for practically oriented navigational education, provide the students with basic hands –on knowledge.
The introduction of Simulators into the education of seafarers has had a number of significant positive Consequences:

- The necessary time to complete seafarer's education has been decreased
- The cost of Education have been decreased
- New Spheres of Education have become possible, in particular, advanced training
- The Standard and Quality of Education have been increased

Simulators allow performing practical exercises in a wide variety of problems in different fields assure preparing future officers to perform their duties at a high standard level.

2. Improving the Crew Personnel Strategy

The human factor is the most important element in merchant shipping which directly affects the safety and security at sea. A well-educated and trained workforce is necessary for a strong and successful water transportation industry. Human factor also affects the competiveness of the shipping companies. MET influences the quality of education of seafarers and their well-being in the future. Seafaring is an international profession and that is the reason why IMO established the common standards for seafarers' education and training.
Improving the personnel strategy includes a general evaluation of the company focusing on a good business plan, analysis of the human resources by establishing the portfolio of human resources and the efficient manning pool and the analyze of the existing situation, of the distributed tasks and of the motivational system.

Maritime companies can assure the adequate resources for the continuous professional training by internal and external financing of professional training.
Finally but not exhaustively, the company should believe in investing in its people for its success, supporting employee development to grow talent from within by using a Performance Management Plan. This is a strategic performance tool which support strategic plan and goal attainment of the organization. The objectives of a Performance Management Plan are to compensate related decisions, promote the crew's potential, establish efficient rewards and recognition systems, helping objective or equitable decision making. By using a Performance Management Plan, the management can identify proper training needs. This tool is also used to document and analyze performance and to promote a high-performance culture.

Education and training of seafarers is still a very complex issue when compared to other disciplines, which requires various considerations to be taken into account for a well balanced MET programme. Therefore, practical training onboard and in the simulators cannot be thought alone for skill enhancement when compared to human performance enhancement in extreme environments such as aviation. Although simulators and sea training onboard a ship plays a very key role for practicality-oriented navigational education, a well developed MET programme must include theoretical and practical education and training in a well-balanced curriculum and must ensure there are well-designed and internationally recognized programmes of education and training leading to higher qualifications and certifications for career progression as well as for job diversification. There is therefore a need for clear education and training pathways recognized internationally with clear progression routes onto degree and higher qualifications in the related subjects **(Albayrak and Ziarati, 2010).**

Figure 2.1: Bridge Simulator
Source: nhl.nl, 2014

A reduction of sea training could provide an opportunity to include good practice courses such as Bridge Team Management, Ship Handling, etc. and also introduce the cadets to the new technology, for instance, developing their competence in the use of ECDIS and AIS. New MET programmes must define the number of simulator hours and subjects that may replace sea training in certain terms and redefine sea training periods accordingly. Good simulator training is expected to include a good set of realistic scenarios based on previous accidents and incidents or near misses.

3. Seafarers Training

The purpose of training and development has been to ensure that seafarers can accomplish their jobs efficiently. Today, the business environment has changed, with intense pressure on organizations to stay ahead of the competition through innovation and reinvention. Strategic positioning of training and development directly promotes organizational business goals and objectives.

Current trends emphasize the importance of training and intellectual capital, a critical factor for competitive advantage. The development of partnerships for knowledge sharing (e.g., consultants and/or academic partners as subject matter experts) has increased. To develop specialized training programs in corporate university settings, training departments often work closely with academic partners to prepare high-potential seafarers for leadership roles. When strategically applied, continuous learning fosters knowledge and skills acquisition to help the maritime company achieves its goals. Human resources department role is to establish and implement a high-level roadmap for strategic training and development. The starting point is an in-depth understanding of the business environment, knowledge of the organization's goals and insight regarding training and development options. Human Resource must then develop strategic learning imperatives (high-level, learning-related actions that an organization takes to be competitive) that align with business goals. Differences in industry, business goals, human capital skills and resources influence the selection of learning imperatives. Professional competence is acquired after passing competency courses, simulation training. For professional competence, an important tools are assessment and on board mentoring. Enhancement is provided by using advanced simulation training, leadership and teambuilding programs, customized training based on the needs of the team. A constant analysis of productivity is also recommended for up to date results. The training system that a competitive company must take in consideration is not only limited to shipboard training. Shore based training implies external courses like STCW 95 mandatory courses, competence and soft skills enhancement courses. In house shore based courses are related to company's system and policies, safety, productivity and loss control. The objectives of structured shipboard training are acquiring theoretical knowledge, familiarization and drills, mentoring and next rank training.

The traditional way of studying human performance in the maritime work domain is through the analysis of accident reports or even better through the analysis of accidents. 80% of maritime accidents are caused by human factors or human error. Experts who make accident reports evaluate in the first stage the human performance in the particular case against the performance standard you could expect from the crew in the given situation. According to international regulations, after any incident needing the involvement of authorities, the first thing an inspector of Marine Investigation Branch does on boarding the vessel is to check the competence and training of the seafarers on board.

Good quality training is a prerequisite to ensuring a vessel maintains a high standard of operation. Training in all its forms adds to the value and safety culture on a vessel. From the legally imposed training certificates of competence to the cadet programs of practice at the board of the ship, it is essential to understand the strategic importance of operating a vessel to the highest levels. For crew members aspiring to higher ranks, statutory training is carried out as they seek for promotion, but a good ship operator will have their own in-house training program that will help reinforce the company's culture and safety. Undertaking responsibility ashore means learning many new skills. Skilled officers make excellent managers but the knowledge prescribed to prove competence at sea leaves gaps in a number of disciplines required in an effective competitive ship management company. A great number of companies today have human resource sections instead of „personnel department" that were used in the past. This is the part of the company that is responsible to the CEO, the board of director and shareholders for ensuring that the operational matters of crew deployment are carried out successfully. (E, Barsan et al, 2012)

4. Competence Based Education and Training (STCW 2010)

A certificate of competence used to be issued by the authorities upon testing knowledge in an examination, assuming that the acquired knowledge would be transferred to a skill and that the required competence of skills would be achieved on the job. However, as achieving the competence on the job is becoming more difficult, the assumption that skills are sufficiently mastered is becoming doubtful and the subsequent assessment of these skills is omitted.

The revision of the International Maritime Organization's (IMO) training Convention (Standards of Certification, Training and Watch keeping for Seafarers STCW 95) has had a considerable impact on the types and extent of training and education and subsequently on the training equipment used.

The specific personnel competences in the shipping industry will require specific types of training equipment to be developed and applied in the education and training of seafaring personnel. A short description is given of modern training equipment whereby the use of simulators is becoming more and more common as can be observed in the workplace. All quality training and educational efforts should include a stage of assessment and evaluation to monitor if the training objectives have been met. As a simulator is a tool in a learning process the requirement to measure the effect of the use of that tool in reaching the teaching objective is as valid as with any other tool. Although not done in a commonly structured manner as assessment in other training systems, some initiatives to assess the effectiveness of simulator training. Furthermore with the revision of the STCW convention more emphasis is justly being put on the qualifications of simulator instructors. In order to justify that result in performance improvement in real life can be compared to the training situation, it is necessary that transfer of training and learning takes place from the training environment to the real life situation.

5. Maritime Simulator

A simulator can be described as a device that duplicates limited aspects of the real world. The simulation process recognizes all the classic benefits such as avoidance of costs and dangers associated with operation of actual systems, avoidance of injury and damage and rapid and repeatable exercises. Compared to conventional training, simulators offer a more structured method of building high levels of competence.
Within IMO an Intercessional Simulator Working Group (ISWG) was established in order to organize and structure simulator related matters for inclusion in the STCW revision. One definition adopted by ISWG (IMO, 1994) reads:
"Simulation is a realistic imitation, in real time, of any ship handling, radar and navigation, propulsion, cargo/ballast or other ship-system incorporating an interface suitable for interactive use by the trainee or candidate either within or outside of the operating environment, and complying with the performance standards prescribed in the relevant parts of this section of the STCW code".

5.1 Maritime Simulator Activities

In general it can be said that any process, which is complex and/or dynamic, is suitable for simulation. In the training of seafaring skills numerous areas are apparent where both elements are present.
A ship simulator is an advanced training device; an electronic or mechanical system used to expose vessel operators and crew members to typical shipboard conditions and systems.

Figure 3.1: Simulation Systems
Source: TRANSAS, 2014

Simulation training is not a substitute for the experience of training on an actual vessel, but is used as a preliminary method to thoroughly familiarize students with equipment, procedures, and processes. Simulation also is useful for review and for demonstrating updates and modifications to existing craft (MarineLink, 2014).
Maritime simulator training started out as radar and ship handling simulation due to the complexity of the then new radar equipment and the need to research vessel movements and reactions in a more economical way than by extensive trial trips.

But in principal any dynamic or complex maritime process that has to be mastered, especially those which are invisible, such as pumping of cargo or ballast, hold a potential opportunity for modeling and thus training by means of a simulator.
The radar and ship handling simulators are the most well known and wide spread, but it is quite surprising to see which other types of activities and equipment have become models for a maritime training simulator system and up to date have been developed and installed: navigation equipment trainer, communication procedures/GMDSS equipment trainer, radar simulator, radar and navigation simulator, ship handling simulator with/without motion platform/image generation, fisheries simulator, inland waterways simulator, dynamic positioning simulator, crane handling simulator, vessel traffic management simulator, search and rescue management trainer, oil spill management trainer, propulsion plant trainer, team generation plant trainer, electrical power plant trainer, refrigeration plant trainer, cargo handling trainer, ballast control trainer, dredging ship trainer, offshore process simulator, drilling technology simulator.
The quality of the impact of simulators in turn is also influenced by a number of distinguishable elements:

- Student
- Instructor
- Programme
- Simulator

Simulator allows mariners access to a real time simulation of the conditions aboard ship--on the bridge, in engineering spaces or in specialized spaces such as cargo handling at a lower cost than teaching classes aboard a training ship. Ship handling simulators are used to train mariners to handle ships in a variety of situations, from docking and undocking, to navi-gating various approaches in a variety of conditions using actual ship performance data in real time.
The key features to a ship simulator are real operational controls and a system that allows the instructors operating the simulator to put the simulator students into realistic situations. All simulators are designed to provide an experience as close as possible to the real world. Bridge simulators provide accurate visual representations through the "bridge windows" and some are even mounting on hydraulic platforms to mimic movement. The speed controls, steering, radar and charting systems are the same found on the bridge of modern ships.

Today marine simulators take over an increasing part in maritime training to raise safety standards. STCW 2010, section A-I/12, contains the standards governing the use of simulators for maritime training of seafarer.

Part 1 deals with the general performance standards for simulators used for mandatory simulator-based training, assessment of competence and in accordance with their specific type (Radar simulation, ARPA simulation).
Part 2 deals with the training and assessment procedures. STCW 2010 section B ex-plains the "Recommended performance standards for non-mandatory types of simulation" "Such forms of simulation include, but are not limited to, the following types:

- Navigation and Watch keeping.
- Ship Handling and Maneuvering.
- Cargo Handling and Stowage.
- Reporting and Radio communications.
- Main and Auxiliary Machinery Operation.

"Navigation and watch keeping simulation equipment should, in addition to meeting all applicable performance standards set out in section A-I/12, be capable to .4 realistic simulate VTS communication procedures between ship and shore"
For the shore side part of VTS communication the IALA Model course V, Part D – Guidelines for instructors, section 5, describes subjects and assessment criteria included in 100 hours simulated exercises.

5.2 Maritime Simulator Classes

The class of simulators which is used for practical training is subject to operational possibilities of the simulator.

It depends on:

- Kind of training which will be carried out.
- Equipment which is installed in the simulator with its realism, operational possibilities and restrictions.
- Possibility of creating various scenarios, in various meteorological conditions, with other ships models in dangerous and emergency situations.
- Training person must have the ability to operate all the equipment which is installed in the simulator, similar to the equipment used in reality.

- Instructor must have the capability to monitor the process of exercise, to record and also to replay it.

With input from the "International Marine Simulators Forum" (IMSF), the classification society DNV▪GL has classed the simulators on functional (functional areas) basis **Table 4.1**. They further subdivided each class into four categories depending on the level of tasks it is capable of simulating.

The following table shows the four simulator classes for the function area "Bridge operation".

Table 4.1: Simulator Classes

Class Categories	Function Level	Simulator Capability
Class A (NAV)	Full Mission Simulator	A full mission simulator capable of simulating a total shipboard bridge operation situation, including the capability for advanced maneuvering in restricted waterways
Class B (NAV)	Multi Task Simulator	A multi task simulator capable of simulating a total shipboard bridge operation situation, but excluding the capability for advanced maneuvering in restricted waterways
Class C (NAV)	Limited Task Simulator	A limited task simulator capable simulating a ship-board bridge operation situation for limited (instrumentation or blind) navigation and collision avoidance
Class S (NAV)	Special Task Simulator	A special tasks simulator capable of simulating operation and/or maintenance of particular bridge instruments, and/or defined navigation maneuvering scenarios

Source: DNV, 2014

The function areas are:

- Bridge operation
- Machinery operation
- Radio communication
- Liquid cargo handling
- Dry cargo and ballast handling
- Dynamic positioning
- Safety and security
- VTS operation
- Survival craft and rescue boat operation
- Offshore crane operation
- Remotely operated vehicle operation

5.3 Quality of Simulator Training Programme

There is a requirement under the STCW 2010 Code that candidates for professional seafarers' qualifications demonstrate competency in the appropriate areas, for example, Officer of the Watch (Navigation).

Assessment using simulation is a legitimate and excellent means for demonstrating competency according to the STCW 2010.

Quality of Simulator Training Program based on the following:

1. Training Objectives
2. Exercise Duration
3. Group Size
4. Instructor Guide
5. Number of Training Scenario
6. Types of Materials available during session
7. Exercise Design
8. Briefing and De-Briefing
9. Assessment

5.4 Design of Simulator Based Exercises

Designing and developing an exercise to be run on simulators is a complex process and involves many important features.

5.4.1 Objectives of the Exercise

How to design an exercise for running on simulator will be governed by the objectives of the exercise. Who are the trainees, what their qualification is and what are the competencies they need to learn. While running a course as laid down in STCW Convention, this may not be a problem as the convention lays down all the competencies required. Simulator instructor will be required to brain storm on deciding the objectives of the exercise when running any special course on simulator which is not given in the STCW Convention. Deciding objectives is very important as it is the foundation stone on which all the variables will be decided and objectives will govern the successive stages one after the other.

5.4.2 Monitoring by the Instructor

It is very important that simulator has the features of a comprehensive monitoring system in order to observe the trainees properly form the Instructor Control Station. Instructor should have multiple ears and eyes and easy control over whole of the working area so that he can perform in a peaceful manner.

Finally, recording of whole exercise including audio / video should be available for re-running in the de-briefing of the exercise and analysis. These will also help in subsequently re-designing and improving the exercise for future running for same level or composition of the trainees.

5.4.3 Briefing and De-Briefing

A briefing has to be conducted before commencement of the exercise by the instructor for the trainees. It is advisable to have briefing in the simulator room itself when explaining various parts and equipment. When more than one instructor / staff is involved, all instructors should be present during the briefing session, thereby giving chance to the trainees to raise questions if any and also to recognize and develop mutual relationship with instructors / staff that will be conducive in achieving the exercise objectives.
Briefing should include all the set conditions of the exercise and exercise objectives; number of trainees involved, trainee leader if any or the team composition, instructors involved and their respective tasks, time duration, break time and duration in the exercise.

5.4.4 Exercise Conditions

Before commencing the active training session on simulator, it is recommended that exercise design should include all the conditions to be set on simulator at start time. This will increase and ensure the validity of the training session.
Conditions include listing of all the equipment that will be used during the exercise and also the equipment which is not fitted or not available during the session. Conditions also include:

- Initial simulator settings, scenarios.
- Equipment fitted / available.
- Equipment made defective as per settings.
- Equipment having any error.
- Weather conditions.
- Traffic conditions.
- Weather and Visibility.
- Ship's position, course, speed.

The scope of a simulator is defined in terms of the different simulation scenarios it can handle. These different scenarios can be further specified according to the following elements:

- Model complexity.
- Implementation flexibility.
- User proficiency.

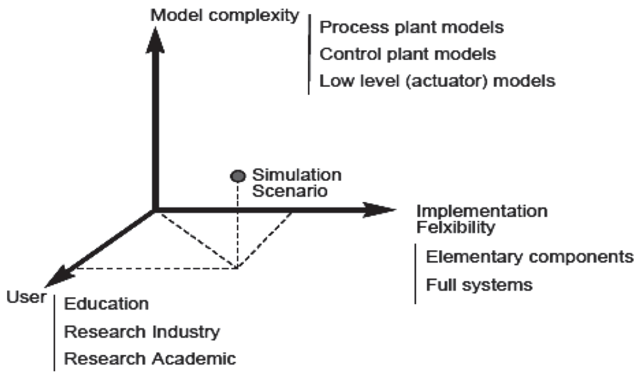

Figure 1: Simulation Scenario Space
Source: (T. Perez, 2005)

Figure 1 illustrates this concept by making an analogy three-dimensional space**. (T. Perez, 2005)**

The *implementation flexibility* of a simulator describes whether existing models and simulation scenarios can be easily adapted to implement new types of systems using the allocated resources. This is a particularly challenging aspect of marine system simulators due to the diversity of ships and offshore structures and the operations they perform. Therefore, openness and modularity of software components have to be prioritized as design principles for systematic reuse of knowledge.
The *model complexity* is determined by the purpose of the model and its simulation. In mathematical modeling, there is a fundamental trade-off between models of great complexity, which yield a highly accurate description of many aspects of real systems and simplified models, which capture the fundamental aspects of the system and are mathematical tractable for analysis (Naylor and Sell, 1982). Within the control literature complex models (*process plant models*) are used to test control strategies and benchmark the more simple models (*control plant models*) used for the design of control strategies and analysis (e.g., robustness, stability, fundamental limitations) (Goodwin *et al.*, 2001; Sørensen, 2005*b*; Sørensen, 2005*a*; Perez, 2005).

5.5 Role of the Simulator Instructor

Simulator instructor has different role to play, he has to take the responsibility of various stages of the training process which include but not limited to the following;

- Knowledge of the subject matter
- Course design
- Selecting appropriate learning activities
- Preparation and use of instructional media
- Assessment and evaluation of the trainees
- Course evaluation and amendments

5.6 Positive aspects of utilizing simulation techniques

The ability to simulate real life scenarios

- Integration into the curriculum to enhance the learning process
- Repeating and enhancing scenarios to improve skill levels
- Allowing students to practice, with instantaneous feedback
- Adjusting the level of difficulty and complexity to accommodate the learner's capabilities
- Giving students exposure to uncommon, and high risk events
- The ability to assess competence in real life scenarios

5.7 Negative aspects of utilizing simulation techniques

- Costs associated with the effort and expertise required to produce realistic simulated scenarios
- Time consuming

In addition to, John Lloyd and Barrie Lewarn added; "Trainees may view it as just a game if the simulation is not realistic".

The increasing number of vessels results in the increased number of situation of nearby collision or even in collisions between ships. Statistical research shows that most collisions are caused by human error. Because of that in the training process of navigational watch-keeping officers, stress is put on learning how to maneuver a ship and how to behave in emergency situations.

The process of training on the bridge simulator is fully controlled by the instructor, safe and much cheaper. Additionally, there is a possibility of carrying out practical exercises on different types of vessels, in various sea areas, in different ports and in various weather conditions

Without proper identification of the type of training which is to be performed it will be more difficult to reach a quality composition of the training in general or training by means of simulators in particular (Cross, 2011).

6. Marine Simulators in Arab Academy for Science, Technology & Maritime Transport (AASTMT)

The Arab Academy for Science and Technology and Maritime Transport, being a regional specialised Organisation of the League of Arab State focusing on issues related to Science and Technology, Supporting its mandate by including an advanced Integrated Simulator Complex (ISC) equipped by the State of the art technologies, and follows a continuing policy in maintaining regular communication and collaboration with the most advanced Simulators in the World.

6.1 Integrated Simulator Complex (ISC)

ISC is one of the most important subsidiary bodies of AASTMT, Established in 1996 with a budget exceeding 65 million dollars in period when the uses of simulator was in part B of STCW. It includes 11 Simulators Operating both individually and collectively to serve the marine professionals and ship staff training and conducting researches

6.2 Maritime College Simulator

AASTMT has opened in 22 of October 2014 a new Simulator Centre in Collage of Maritime Transport and Technology which includes 3 Main Simulators:

- ECDIS/Radar & ARPA Simulator
- Liquid Cargo Handling Simulator
- Engine Room Simulator

These Simulators are considered as the state of the art in technology introduces newly developed training methods and meet the STCW requirement as amended in 2010 which provides real time simulation to supplement the traditional methods on board training. Simulator centre established to train the college undergraduate students to ensure the completion of simulator mandatory courses in parallel with the student graduation.

Maritime College Simulators in AASTMT can create various scenarios based on different sea areas, such as open sea passages, fairways, as well as harbor areas etc. Students will receive an assessment paper in a simulator with prior aims and objectives including a time limit. They will place in a navigation marine simulation scenario designed by the instructor. Before commencement, they brief on the exercise requirements, geographical area and the ship's handling characteristics. Assessments carried out on state of the art ship simulators that replicate real ships' navigating bridges. The exercise time can set in night time, so that students could identify lights from navigational marks. One participant occupied each bridge during assessment. Five bridges were available in every class room and therefore 20 students were assessed in each exercise session.

During the exercise, students carried out a number of competency-based tasks, monitored by observation through the instruction station and their action work on the Electronic Charts. The score can give for the students' performance and work, based on the marking system. The exercise was piloted and adjusted as necessary. This to ensure that the student exercises would run without technical problems. The exercises were designed and marked according to the principles of AASTMT Simulator assessment System

7. Conclusion

Simulation assessment is perceived by students to be more difficult than written examinations because a greater degree of understanding is required. This perception reinforces the view that simulation assessment is a better means of determining competency than written examinations. Simulator training approval elements are: the simulator characteristics, the validity and reliability of the simulator, the training programme and the knowledge and capabilities of the instructors.
Simulator training is expected to include a set of realistic scenarios based on previous accidents and incidents or near misses. Development of modern simulation technologies makes seafarers' training on a professional ship simulator possible and unlimited

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vessels are major obligations for the ship company to in order to upgrade compliance with the environmental regulations.

The purpose of this paper is to develop an environmental policy for reducing and minimizing marine and air pollution from ships' operations and disposal of wastes to oceans, to air, and suggestions of technical solutions on-board the company vessels. The policy is most likely derived from the objectives of the international and national regulations, concerning the obligations of the ship-owners for a safe and clean sea. Discussions in this paper focus more on the recent regulations and environmental issues of shipping.

2. Regulations and Technologies must be on-board vessels

Lists and locations of special areas shall always be provided on-board vessel for better management and operation of wastes. International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) prohibits discharges of dirty ballast, plastics and sewage on special areas. Therefore such special areas approved by IMO, must be known by all the company fleet for appropriate measures taken, to minimize the disposal. Also all the emission control areas for SOx, NOx and particulate matters are provided in the ships with updates in every new entry to the list. Plans and procedures of all the technologies and operational plant of the vessel must be carried on-board for the concern of staff and crew members. For instance, if alarm goes off, crew members must already know what to do and which operational plan is it. Documents and certificates issued for the ships' information must be ensured that it is carried on-board at all times. However it would be nice if network communication on-board and land based is available, for when is needed and for assessment or auditing. Therefore installing computers networkson-board for communication will also help.

2.1 Oil and Chemicals Handling

Loading, discharge and bunkering procedures and any use of the chemicals must be notified of locations on-board ship with chemicals category, and labelled of danger classification or announcement, to inform all persons on-board. Even for chemicals usedon-board vessels is applicable. Everyone must also know that discharging and throwing overboard of any chemical is prohibited, and standards must comply with MARPOL annexes II and III as well as International Maritime Dangerous Goods (IMDG) Code. *'No discharge overboard'*.

Since the discharge of oil on certain circumstances is allowed with certain standards as referred to MARPOL 73/78, the company can make it a higher standard for discharge of oil at more than 50 nautical miles from nearest land and oil contents of 15 part per million (ppm). Therefore, oil filtering and monitoring system as well as oil/water interface detector is required on-board in all the company vessels to control the discharge standard and minimize discharge higher contents of oil. Furthermore, there is a new technical solution called Bilge Water Processing System (White Box) this system can be considered as resistant fail-safe system for overboard discharge of bilge water, which finally monitor and control the through out of bilge water passes before reaching the environment.

2.2 Sewage Regulations

Ship-owner and operators especially on passenger ships must ensure that all toileting arrangements on vessel be installed or modified in compliance with MARPOL Annex IV requirements. The ships must be fitted with sewage holding devices, also fitted with visual means to indicate the amount of its content and having treatment plan, carry sewage record book, and fitted with sewage treatment system such as aqua-mare, max and mini-san or eco-tank sewage holding *(NWSA, 2009)*.

The Marine Sanitation Device (MSD) may also be used on treatment of the black water. Different sewage systems can be used on-board vessels are major obligations for the ship company to in order to upgrade compliance with the environmental regulations.

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The Marine Sanitation Device (MSD) may also be used on treatment of the black water. Different sewage systems can be used on-board ship whether cargo or passenger ships with MSD or portable toilets. Different types of MSD standard, under the Clean Water Act (CWA) of America are more suitable to use on-board. Advanced Waste water Purification system &Ultraviolet systems are suggested for use of solid material on-board to treat greywater which comes from showers and toilets and black water which comes from the hospital sewage. However, it would be better of a higher standard if the sewage treatment system has automated alarm device to give warning for any overflow or exceeding the standard. A higher standard set for all the company ships of sewage discharge at no less than 12 nautical miles to nearest land and not less than 7 knots. Moreover, Jet Vacuum system is one of the technical solutions which can be fitted on the new and existing ships; this system is designed to improve the management and the treatment of the black water by using less chemicals and energy to treat the swage *(EPA, 2009)*.

2.3 Garbage Regulations

MARPOL annex V required the following measures; every ship of 12 meters or more in length shall display placards which notify the crew and passengers of the disposal requirements, every ship of 400 GT and above shall carry a Garbage Management Planin this plan shall provide written procedures for collecting, storing, processing and disposing of ship-generated garbage including the use of the equipment on board, and every ship shall carry a Garbage Record Book in this record book each discharge operation or completed incineration shall be recorded and signed for on the date of the incineration or discharge. In addition, to the Garbage Record Book there is a new measure are given by some ports to the ships the White Paper, which is given to the ship to show that the ship is clean from garbage when they dispose the garbage to the port reception facilities.

The existing ships must carry marine incinerators which are mainly designed for irregular operation, and one of the technical solutions nowadays is Upgrade Incinerators which allow the ships to burn the garbage waste more efficiently using less energy and reducing air emission especially the emission of nitrogen oxides (NOx) and carbon monoxide (CO).Another technical solution is The Plasma Incinerator Waste Disposal which allows the ship to burn the garbage waste efficiently and results in a significant reduction of the air emission and ash by-product of incineration.

2.4 Air Emission

To begin with, the revised Annex VI of MARPOL allows the different countries to designate Emission Control Areas (ECA), there is a need to update technologies and control of emission of SOx, NOx and particulate matters from ships. The revised NOx Technical Code 2008 is an essential publication for shipping companies, educational institutes, engine and equipment manufacturers and others with an interest in the prevention of air pollution from ships. NOx Technical Code 2008 is mandatory for all marine diesel engines with a power output of 130 kW or more. This code provides the requirements for the testing, survey and certification of marine diesel engines *(IMO, 2009)*. The ‘Tier III’ engine which is standards apply only for NOx Emission Control Areas has been agreed by IMO to install on ships building after January 2016 as shown in figure 1. Also, it is recommended that the shipping companies can start installing them on rebuilding existing ships.

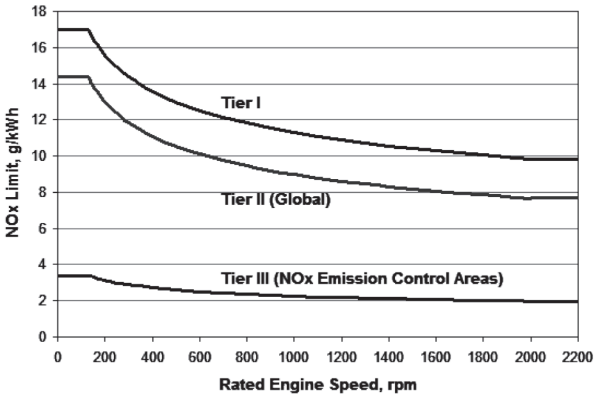

Figure 1. MARPOL Annex VI NOx Emission Limits
Source: Michael F. Pedersen, September 2011

Low sulfur fuel is also recommended to use for ships engines and the sulfur limits and implementation dates are listed and illustrated in Figure 2.

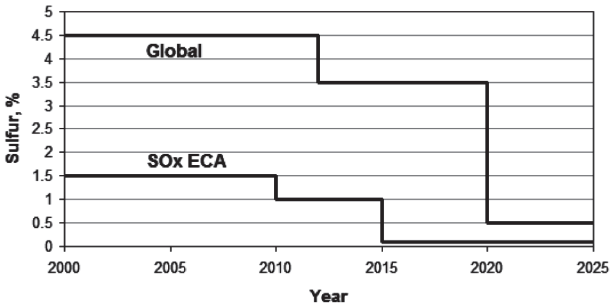

Figure 2. MARPOL Annex VI Fuel Sulfur Limits
Source: Michael F. Pedersen, September 2011

Selective Catalytic Reduction (SCR) Converter system is a catalytic exhaust gas purification plant which reduces harmful components in diesel exhaust. SCR use urea as reactant which converts nitrogen oxide into water, nitrogen and carbon dioxide. Urea is a chemical commodity used for NOx reduction in combustion processes and a raw material in wide range of products. Therefore, there are no waste products involved with the SCR and reduction of NOx in different rate of urea injection. The heating ventilating and air conditioning (HVAC) systems should be used onboard to control the temperatures and it help to reduce the use of diesel and heavy fuel on operating engines for controlling of temperature. Therefore, reduce the amount of air emission because the energy consumption of the HVAC system is less, which also include alarm device and zoning system with feedback system to give information on the alarm zone of the emission from the machine. However, both HVAC and SCR are recommended to be used on board the company vessels, as well as Tier III engines to minimize the hazardous air emission.

The Exhaust Gas Recirculation (EGR) in the MAN diesel engine reduce the NOx with 60% and the wet scrubber with high pressure scavenge air receiver in the ERG cleans the exhaust gas by removing SOx and its particles (*Marine Propulsion, 2007*). In addition, another technical solution is the Seawater Scrubber Feasibility (SSF), in this system the seawater scrubber use the natural chemistry of the seawater to remove nearly all the SOx and particulate matter from the air emission. Finally, when ships entering or leaving designated Sulfur emission control areas (SECAs) the ship must switch over between using low and normal Sulfur fuel oils that can be result in optimal consumption of expensive low Sulfur fuel (*Gilligan, 2008*).

Another result of air emission from the ships engines is the CO2 gas, which is a colorless and non- toxic gas, but have very heavy impact on the environment such as; CO2 which is the major greenhouse gas contributing to global warming of the earth, rising the sea level and have potential impact on the ocean current system and changes in agricultural conditions (*Hellen, 2003*). Therefore, there are several measures introduced in order to reduce CO2 emission from ships such as ; improving hull forms, improving anti-fouling paints, improving propulsion systems, changing in the bulbous bow construction and reducing ships service speed (*Svenning, 2007*). In addition, the Exhaust Gas Recirculation (EGR) in the MAN diesel engine at 100% engine load reduces the CO2 emission by around 18 % (*Marine Propulsion, 2007*). Moreover, in VLCC if the service speed reduced by 10% from 15 knots to 13.5 knots the daily fuel consumption will be reduced by 25% to about 75mt, such reduction will reduce CO2 emission about 80mt per day (*Svenning, 2007*).

2.5 Ballast Water

Ballast water is sea water that carry organisms which most likely to be invasive species in most of world ports. At least 7,000 species which IMO considers 'invasive aquatic species' which cause disaster to the marine ecosystem, transported in ballast by ships, as one of the major threats to the marine environment (*Globallast Partnerships, 2009*).

There have been various methods proposed as the solutions to this matter, three ballast water treatment arrangements seen possible were ship-board treatment, port-based treatment and land-based treatment *(AQIS, 1993)*. Among the treatment methods, the on-board treatment plant was viewed as the best method to be used. IMO Resolution A.868 (20) a guideline for the control and management of ship's ballast water to minimize the transfer of harmful organisms and pathogens. Based on the AQIS report on ballast water treatment technologies on-board; physical processes such as screening, gravity process, filtration, thermal processes and radiation were all suitable and ranked from good to worst in different circumstances. Chemical treatment such as using chlorine and organic biocides seems not to be the best practice because they perform highly on removing the organisms in the ballast water but they have very poor acceptability on the environment *(AQIS, 1993)*. Therefore, using chemical for ballast water treatment is not acceptable.

After realizing that ballast water exchange is a threat to the vessels safety, and then alternatives of on-board treatment were proposed. However, the problem is still unsolved because the system seems unclear. While ballasting, Ultra Violet radiation (UV) may be used, the sediments is a problem which blocks the UV radiation from killing the organisms. Filtration occurs when de-ballasting, at the same time samples also taken. The sample is to check if the discharging ballast standard is environmental friendly. A suggestion on ballast water technologies on-board is a separate tank with computerised automated alarm system, like stability control system, for pre-treatment processing, removal of sediments and organisms, then thermal method application while ballasting and before de-ballasting (*Tjallingii, 2001*).

2.6 Anti-Fouling

There is a connected relation between MARPOL annex VI and the anti-fouling system, that when the underwater area of the ship have fouling that will lead to increase the friction drag, which will lead to increase the fuel consumption, which will accelerate the emission of the greenhouse gas CO2 and increase the acid rain which comes from the exhaust gases NOx and SOx. On the other hand, these paints contain Tributyltin (TBT) which is highly toxic to the marine organisms, causing toxic sediment on the sea bed and causing problems with the reproduction of the most sensitive species in the sea water. Therefore, one of the measures mentioned in the Anti-fouling system convention which enter into force 17 September 2008 is that all existing ships must comply with the convention regulation by replacing the hull paints in the next dry dock and to have initial survey in order to issue the International Anti-Fouling System certificate (IAFS) (*IMO, 2002*).
There are some technical solutions such as; having the silicon based anti-fouling marine hull coating system, which reduce the ships drag, reduce fuel consumption and air emission and another marine hull coating system which obtain fewer volatile organic compounds released during painting and less time spent in dry dock(*Lloyd's list,2008*).Finally, as Capt. Robert Johnson, the Head of Worldwide Shipping Operations said "We believe the benefits from this type of antifouling coating will contribute to a reduction in the vessels environmental footprint by eliminating biocides and reducing emission "(*Lloyd's list, 2008*).

3. The Environmental Management Policy

Environmental awareness amongst the staff, crew and passengers on-board ships is very important. In order to increase the awareness, environmental training, drills and other means of message delivery are to be carried out. Shipping is a continuous activity, therefore the energy consumption and on-board generated wastes, need to be controlled and reduced for environmental friendly disposal to the environment. All the company vessels, whether cargo carriers or passengers ships, strive for the best in compliance with all the international and national regulations regarding pollution prevention and protection for minimizing and reducing impacts on environment.

The vessels are to be checked and inspected regularly as well as carrying out audit internally and externally for improvements of ships' standards. The introduction and development of the use of efficient and effective technologies, equipment, and facilities for reduction of waste disposal is one of the objectives. International Standard for Environmental Management Systems (ISO) issued environmental certificate (ISO 14001) and International safety management (ISM) is to be considered for the safety of the ship and persons on-board the vessels. Therefore environmental communication is very important within the company. The company shall continuously improve the environmental friendly performance and continuously reduce the environmental risks. Not only that but ships must be managed from birth till grave, therefore the company must comply with all the ships recycling guidelines. In that way, the company shall also encourage the suppliers, dealers and other business partners to develop their environmental work. However, all the environmental measures including training, technology introduction, environmental requirements and audit checks on the customers, the outside parties shall be of confidence of the measures taken by the company. Finally, list and locations of special areas and emission control for different discharge of wastes are to be provided onboard ships for information and compliance with the regulations.

3.1 Policy Analysis

The company shall recruit competent crew on the ships and well qualified officers such as environmental officer on passengers' ships. IMO and other international organizations urges the training of seafarers as priority on the agenda as well as calling upon shipping industry to take the lead by promoting itself and doing more to make the life on-board more akin to the life enjoyed by others ashore . Training should be provided especially for those who are involved in disposing and operating the waste processing equipment whether oil, sewage, garbage, engines, ballasts and chemicals. International Standard for Environmental Management Systems (ISO 14001) which helps with Environmental Policy, Impact Reduction, Pollution Prevention, Legal Compliance, Culture Change, Corporate Responsibility, Reputation, Resource Management is considered to train the crew and staff on-board the ships to Identify potential impacts and implement controls and measures to keep risk as low as possible, Understand how statutory and regulatory requirements impact your organisation and stay on the right side of the law.

There are many ways in which training can be carried out, such as by using posters, brochures, photographs, video tapes on-board and having the company channel on-board for the safety and environmental programmes *(ABS, 2005)*. All competent crew and qualified staff should be well trained to be familiar with activities, operations and procedures on-board vessel in the most environmental friendly manner. Company TV channels on-board vessel help the training of passengers to be aware of the on-board environmental rules.

Record books on-board vessels are very important in preventing the disposing of oil, sewage, ballast and garbage illegally. Therefore staff and crew need to be trained to properly deal with. In this way auditing corrective actions develop better management of training. Communication amongst the crew, staff, not only on-board the vessel but also between the ship and land based staff concerning environmental issues need training for better understanding and cooperation. The company may encourage higher educational level, regarding marine environment and measures taken in protecting and preventing marine pollution. Regular drills and training lead to better management, solutions and ideas that contribute to raising the standard of the company.

4. Conclusion

International and national regulations on prevention and controlling marine pollution seems to be continued as new issues on the environment, therefore new regulations will continuously put up for compliance until the problem is minimized. There are no particular solutions even with technologies for most of the environmental problems but controlling the human activities by the regulations, help minimize the impact on the environment. Introduction of new technologies on rebuilding existing ships must also consider the safety issues of the ships in relation to the pollution reduction and minimizing control with the international and national regulations. Amongst the technologies is wastewater purification, air emission reduction, high efficiencies appliances, low sulphur fuel, solid and liquid waste processing, pollution education and training programme are considered to help the prevention and minimize environmental damage.

New technical solutions such as **X-bow** in the offshore market and **sky sails** reduce of 50% of fuel consumption with good wind condition, which will be available on 1500 ships by 2015, will lead to survival of the environment. Moreover, Emissions trading is an administrative approach used to control pollution by providing economic incentives for achieving reductions in the emissions of pollutants. It is sometimes called **cap and trade**. Companies are issued emission permits and are required to hold an equivalent number of credits which represent the right to emit a specific amount. The total amount of allowances and credits cannot exceed the 'cap'. Companies that need to increase their emission allowance must buy credits from those who pollute less, The transfer of allowances is referred to as a 'trade', In effect, the buyer is paying a charge for polluting, while the seller is being rewarded for having reduced emissions by a percentage higher than required. Thus, in theory, those who can easily reduce emissions most cheaply will do so, achieving the pollution reduction at the lowest possible cost to society. There are active trading programs in several pollutants. For greenhouse gases the largest is the 'European Union Emission Trading Scheme (EU ETS)'. In the US there is a national market to reduce acid rain and several regional markets in nitrogen oxides. Markets for other pollutants tend to be smaller and more localized.

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Evaluation of Simulation Training in the College of Maritime Transport in AASTMT

Tawfik Mostafa Khattab

Abstract

Since the 1960s, simulation training has been used to train maritime officers and engineers. Simulation training do not only test acquisition of knowledge but also assess the attainment of competences and abilities required by sea farers. A U.S. Coast Guard (USCG) study in 1996 concluded that simulation is effective in areas such as Bridge Resource Management, Ship Handling, Docking and Undocking, Rules of the Road, Emergency procedures, etc. However till now the impact of simulation training on mariner's performance has not been evaluated through accurate measures. This study aims to investigate the perception of midshipmen of the Maritime College, Arab Academy for Science, Technology and Maritime Transport on simulator training.

1. Introduction

However, there is not enough data to determine the impact of simulator training on mariners' performance. Along the same line, simulators and simulator instructors still lack international standardization, validation and periodic recertification in order to ensure its reliability in training and assessment of maritime officers.

A Simulatoris the hardware and software that generates the simulation. *Simulation* is the representation of conditions approximating operational conditions. Different scenarios are created for different simulation environments with each scenario aiming to teach or assess a specific competence or proficient. The simulator provides the interactive environment to apply theoretical knowledge learned in class rooms and to develop actual competences. A simulator fills the gap between theory and application (MacElrevey, 2004).

2. Standards and Classes of Simulators

Det Norske Veritas (DNV) has classified simulators into four categories as follows: **Category I: Full mission which** is capable of simulating full visual navigation bridge operations and pilotage training in restricted waterways. **Category II: Multi-task which is c**apable of simulating full visual navigation bridge operations similar to Category I, but excluding the capability for restricted-water maneuvering. **Category III: Limited task which is** capable of simulating a limited environment such as navigation or collision avoidance. **Category IV: Special task which is** capable of simulating particular bridge instruments, or limited navigation maneuvering scenarios, but with the operator located outside the environment.

The amendments of the Standards of Training, Certification and Watch Standing (STCW) 1987 in 2010 specified mandatory standards and requirements for simulators used in mandatory training or assessment of seafarers (Regulation I/12 of STCW 78, as amended 2010). Code A-1/12 specified these performance standards of simulators, training and testing procedures. These specifications included detailed standards for RADAR and ARPA simulators but general standards were specified for other simulators. More detailed standards should be addressed for all simulators as to ensure the realism and effectiveness of simulator training in the international community.

3. Simulation Methods

Simulation methods can be divided into three groups: **Non-Interactive simulation**, interactive simulation by physical models or simulators. Non-Interactive simulations do not allow human interactions and often called fast-time simulation as they are used in preliminary investigations and not used for training or assessment. **Interactive Simulation by Physical Modelsis** called **manned models** because humans actually interact with the physical model as shown in Figure 1. They are mainly used to train Pilots and Captains.

Figure 1: Interactive Simulation by Physical Models (Port Revel- United Kingdom, 2015)

Interactive simulation by simulators is referred to as **real-time simulation** as a human operator interacts with a bridge simulator. These simulators are used for research and training of pilots, ship captains and tug masters as well.

Figure 2: Bridge Simulator (Uniteam Marine, 2015)

4. Literature Review of the Impact of Training Using Simulators

This section will review some of the literature that studied the impact of simulator training to enhance sea farers competencies. Simulation training has been used to train seafarers since the sixties, when it introduced the assessment of competences over the traditional test of knowledge.

In 1993, the United States Coast Guard (USCG) stated that even though there are not adequate statistics to judge the influence the use of simulators has had in improving seafarer performance, but, there is satisfactory experience to ensure its use. They highlighted that in order to use simulation effectively in training, licensing, assessment and evaluation of sea farers, it is important that the issues of standardization and validation of simulators be strongly researched and addressed (USCG, 1994).

In 1996, the US National Research Council (NRC) conducted a study concerning the efficiency of simulators in training and testing sea farers and confirmed USCG results as they concluded that not enough data was available to determine whether ship-bridge simulator was more effective than traditional training.

As marine casualties increased, concerns prevailed within the shipping industry about mariner proficiency and competence. In 2008, Constanza Maritime University noted that even though the shipping industry has concentrated on improving ship structure and development of navigation equipment over the last forty years, the rate of maritime incidents is still high. Hnzu el al. (2008) stated that increased automation in the bridge have decreased the workload but also increased the risk of unintended human error leading to accidents. In 2008, Hnzuet. al concluded that 85% of all accidents were committed by human error, which agrees with findings of Ziarati (2006), (IMO, 2005) and confirmed by the data published by the Main Search and Rescue Coordination Centre of Turkey in 2009. Much of the efforts to reduce human error and marine casualties aimed towards the enlarged use of simulators.

In 2012, Lindmark analysis of the feedback from students attending the Tanker Cargo-handling simulator course at Chalmers University of Technology concluded that more time is needed to practice on simulators aiming to better improve understanding of course literature. In summary, it is noted that simulation training is highly regarded as a promising tool to increase sea farers' competency, but still much effort is needed to ensure its standardization and validation. The following sections presents study conducted on midshipmen in the Arab Academy for Science, Technology and Maritime Transport (AASTMT) concerning their simulation training.

5. Data:

A total of 120 questionnaires were distributed to seventh and eighth term midshipmen of the Maritime College. Only 98 questionnaires were fully completed. 41 questionnaires were discarded as they were filled carelessly. Finally, Only 57 questionnaire were available to analyze and infer logical explanations of student behavior.

6. Descriptive Statistics of collected Data:

The data collected contained the Grade Point Average (GPA) and Perceived Competence in Navigation represented by the variable (PNAV). The following sections will describe their statistical distribution.

6.1. Description of Grade Point Average Distribution among respondents:

Descriptive analysis of Grade Point Average (GPA) of respondents revealed that the mean GPA was 2.66, with a minimum value of 2.0 and a maximum value of 3.9 which covers the whole range of GPA from 2.0 to 4.0 as shown in Table1 1.

Table 1: Descriptive Statistics for GPA of all Respondents

	N	Min.	Max.	Mean	S. Deviation	Skewness	Kurtosis
GPA	57	2.0000	3.9000	2.658596	.4647558	.626	-.018

Kurtosis was -0.18 indicating the bending of the curve to the left, which is confirmed from the curve of frequency distribution of the GPA of respondents as the curve is more bending to the left than to the right as shown in Figure 3.

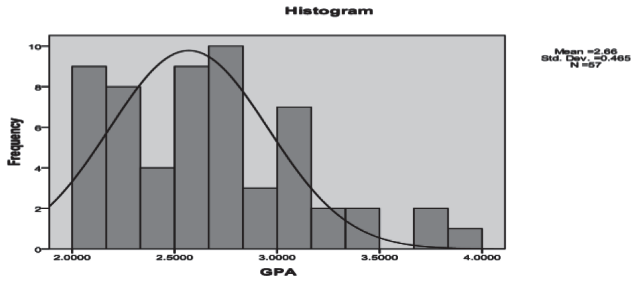

Figure 3: Histogram of Frequency Distribution of GPA of Respondents

6.2 Description of Personal View of Competence in Navigation among respondents:

Descriptive analysis of how midshipmen viewed their competence in navigation revealed that the mean value was (3.77), minimum value was (1.0) and maximum value was (5.0) as shown in Table 2

Table 2: Descriptive Statistics for Navigation Competence of all Respondents

	N	Min.	Max.	Mean	S. Deviation	Skewness	Kurtosis
PNAV	57	1	5	3.77	1.165	-.799	-.140

To further test the relationship between Student GPA and how he evaluated his competences in navigation, correlation analysis was conducted on both variables GPA and PNAV. It was found that there is no significant correlation between both variables at the p value less than 0.05 as shown in the Table 3.

Table 3: Correlations between GPA and PNAV

		GPA	PNAV
GPA	Pearson Correlation	1	.201
	Sig. (2-tailed)		.133
PNav	Pearson Correlation	.201	1
	Sig. (2-tailed)	.133	

It is evident that how students judge their competences in navigation is not related to their tests and evaluation scores and overall GPA. It is concluded that the measure how students rate their competence in navigation could not be used to indicate actual competence in navigation since it is not correlated to GPA and appears to be greatly biased by individual view. GPA would be used as an indication of competence in navigation rather than PNAV.

7. Statistical Comparison between In-class, Simulation and Sea Training Methods

7.1. Compare Effectiveness of Training using In-Class, Simulators and Sea Training:

T-Test statistical method was used to compare the means of midshipman perception of how effective is training using In-Class versus simulators and sea training. Table 4 summarizes the statistical findings of the comparison of means of the above variables. It was found that In-Class training is most effective to teach midshipmen basic navigation methods. Simulator training was found to be the least effective method in training midshipman on basic methods. Training at sea better than simulator training by a small margin. These results indicate the need to emphasize and improve the effectiveness of training in simulators and at sea

Table 4: Mean of Effectiveness of Training in Class, Simulator and/or at Sea.

	N	Mean	Std. Deviation	Std. Error Mean
PEffectiveness_Nav	57	4.70	5.127	.679
PEffectiveness_Sim	57	3.54	1.226	.162
PEffectiveness_Sea	57	3.72	1.161	.154

7.2. Compare Time dedicated to Training using In-Class, Simulators and Sea Training:

T-Test statistical method was used to compare the means of midshipman perception of time dedicated to training using In-Class versus simulators and sea training. Table 5.5 summarizes the statistical findings of the comparison of means of the above variables. Students indicated that time allocated for all three types of training was enough. However, time of training at sea was more than enough, followed by time of training In-class. Students indicated that time of training on simulators could be increased as it was the least value among all three types of trainings. These results indicate that students view that time to train in simulators could be increased as compared to other training types.

Table 5: Mean of Time Enough for Training in Class, Simulator and/or at Sea.

	N	Mean	Std. Deviation	Std. Error Mean
PEnoughTime_Nav	57	3.51	1.037	.137
PEnoughTime_Sim	57	3.40	1.307	.173
PEnoughTime_Sea	57	3.54	1.196	.158

7.3 Compare Difficulty of Training using In-Class, Simulators and Sea Training:

T-Test statistical method was used to compare the means of midshipman perception of difficulty of training using In-Class versus simulators and sea training. Table 5.6

summarizes the statistical findings of the above comparison. Students indicated that it is most difficult to train using simulators than in-class or sea training which students viewed of equal difficulty. To reduce the difficulty of using simulators it is recommended to increase familiarization time when first midshipmen are introduced to simulators. Even though students regarded time to train in simulators is adequate, but spreading simulator tasks over longer training periods should aim to reduce the difficulty of using them.

Table 6: One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
PDifficulty_Nav	57	3.26	1.316	.174
PDifficulty_Sim	57	3.49	1.390	.184
PDifficulty_Sea	57	3.26	1.408	.187

7.4. Compare Reality of Training using In-Class, Simulators and Sea Training

T-Test statistical method was used to compare the means of midshipman perception of reality of training using In-Class versus simulators and sea training. Table 7 summarizes the statistical findings of the above comparison. Students indicated that training at sea has the top reality, more than training using simulators which is more than in-class training. These results were expected as they follow common logic of training. However, training using simulators could be more realistic given the more the experience of the simulator instructor and the more realistic the simulation exercise.

Table 7: Comparison of means of Perception of Navigation Skill Statistic

	N	Mean	Std. Deviation	Std. Error Mean
PRealistic_Nav	57	3.53	1.255	.166
PRealistic_Sim	57	3.61	1.206	.160
PRealistic_Sea	57	3.75	1.154	.153

7.5. Choose Best Type of Training using In-Class, Simulators and Sea Training:

T-Test statistical method was used to compare the means of midshipman perception of best means of training is sea training. However, they still view training using simulators as better than training using In-Class exercises. Table 8 summarizes the statistical findings of the above comparisons. Students indicated that training at sea has the top reality, more than training using simulators which is more than in-class training. These results were expected as they follow common logic of training.

Table 8: Comparing Best Type of Training from Students Point of View

	N	Mean	Std. Deviation	Std. Error Mean
PBest_Nav	57	3.19	1.246	.165
PBest_Sim	57	3.46	1.415	.187
PBest_Sea	57	3.89	1.113	.147

8. Results and Conclusion

Results indicated that students GPA was not correlated with their perception of their competence in navigation. Students with higher GPA viewed themselves as needing more training in Navigation, while students with lower GPA viewed themselves as competent in navigation. This is contrary to what was expected. This could be explained due to the fact that students lack the experience to compare their competence level.

Comparison between in-class, simulator and Sea training is presented in Table 6. Students viewed **In-class training as more effective than at sea or simulator**. They also viewed **time allocated to train on simulators not enough.** This indicates the need to allocate more time train on simulators. **Simulator training was also viewed as most difficult** when compared to in-class and sea training. This is also expected as simulator equipment need familiarization time before actual usage in different exercises. Simulators are viewed by students are real after sea training and also viewed as best training method of sea training. A summary of results finding is concluded in Table 9.

Table 9: Comparison of Top Qualities in Training

Item	Effectiveness	Enough Time	Difficulty	Reality	Best
Top	In-Class	Sea	Simulator	Sea	Sea
Second	Sea	In-Class	Sea	Simulator	Simulator
Least	Simulator	Simulator	In-Class	In-Class	In-Class

It is concluded that midshipmen of the Maritime College of AASTMT consider simulator training more **realistic** than in-class training and after sea Training. Even though they consider simulation training as the best training method after sea training, yet they evaluate simulation training as least effective. Reasons for this include difficulty of training using simulators and not enough training time on simulators.

9. Recommendations:

Midshipmen should be assigned more training time on simulators. Simulator training must not start until thorough familiarization for all trainees is completed on simulator equipment. Exercise difficulty should gradually increase as trainees become more familiar with the simulator. However, more research is required to further improve the efficiency of simulator training.

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The Importance of the International Convention for the Control and Management of Ship's Ballast Waters and Sediments, 2004

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Abstract

Ballast water transferred through ships introduces aquatic organisms and pathogens from one coastal region to another, causing ecological, environmental and human impacts. Through various instruments, the international community showed great concern to overcome this problem and to preserve ecosystems and biodiversity. Eventually, the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 was adopted by the International Maritime Organization (IMO) as a legal regime to prevent, control and ultimately eliminate the spread of harmful aquatic organisms and pathogens transferred by ships' ballast water and sediments. The Convention sets out regulations, flag State obligations and technical guidelines to be implemented. Yet (Sep. 1st 2015), the Convention has not entered into force.

This paper evaluates the ability of the Convention to achieve the aim to prevent and eradicate this source of marine degradation. The Convention establishes a useful global tool that puts forward certain practices and steps that can be taken toward combating the transfer and spread of harmful organisms and pathogens across the world's coasts and marine areas. However, its potential is undermined by some factors, such as the exemption of some categories of ships from its application, and financial cost, especially to developing countries of implementing its requirements. Besides, the purview of the Convention does not account for other significant sources by which harmful organisms are spread.

It is also advisable to rectify some of the deficiencies in the formulation of its regulations. Thus, if the Convention is ratified by an adequate number of States as well as adopting additional laws to regulate areas not addressed by the Convention, the protection of the marine environment will be more efficiently enhanced.

1. Introduction

"Ballast" is the water stored in ballast tanks, which are iron tanks in the holds of a vessel that can be pumped full or free from water, to give the vessel necessary draught when little or no cargo is on board. For the cause of safety, ships require ballast to maintain stability throughout their voyages. In the past, rocks, gravel, stones, sand, or heavy iron rods were utilized as solid ballast to balance seagoing vessels. Nevertheless, their use was expensive, and time and energy consuming. In the late 19th century, with the advent of steel-hulled ships, the marine world tuned to making use of salt water as a means of balancing vessels partially laden with cargo. Water is much easier to load and discharge, and more manageable and economical than solid ballast. (Lawal, 2011)

Over 80% of the world's commodities are moved by shipping, which transfers roughly 3 to 5 billion tons of ballast water around the world annually. Essential as it is for maintaining ships' balance, ballast water poses a serious ecological, economic and health threat through the introduction and spread of about 7,000 Invasive Aquatic Species (IAS), also known as Harmful Aquatic Organisms and pathogens (HAOP), unintentionally carried around in it. When discharged into new environments, they may severely disrupt the native ecology, negatively affect the economic activities and cause adverse human health problems. (Lloyd's Register, 2015)

There are myriads of examples of severe ecological, economical and human health impacts from harmful aquatic species globally and the costs associated with invasions are in the range of hundreds of billions US dollars. In the 1980s, the introduction of these organisms began to be viewed as a salient threat to the marine environment. It all started when Australia and Canada were having difficulties with invasions of non-indigenous species and conveyed their concerns about the problem to the IMO. The objective of the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 adopted by the IMO was to curb the inadvertent transfer of harmful aquatic species through ships' ballast water. (Lawal, 2011)

In this paper, some issues related to the Convention are discussed. First off, an explanation of the nature of the aquatic invasive organisms is explained, including their ecological and economic impacts as well as their effect on the human health. Second, an orientation to the overview, articles, application and general obligations of the Convention is provided. Third, there is a discussion of the available methods of managing and treating ballast water. Finally, the strengths and weaknesses of the Convention are evaluated, along with some recommendations.

2. The nature of Aquatic Invasive Organisms

All aquatic environments, various organisms of diverse species and pathogens exist. Most of these organisms cannot be seen by the naked eye in the early stage of their life cycle without using a microscope. These aquatic organisms are given different names by various authors. They are interchangeably described as alien, new, non-indigenous, foreign, non-native or exotic. The introduction of such invasive species may endanger the marine environment, causing significant and harmful changes and impairing biological diversity. (ClassNk, 2015)

Although the majority of species introduced to a new environment cause no or little noticeable change in a local ecosystem, some introduced species, under certain circumstances, become established and, in the absence of natural controls such as parasites or predators, drastically change the ecosystem. Such species are described as Invasive Alien Species (IAS). Natural controls help maintain their population numbers in natural balance; however, the lack of those controls leaves room for those species to rapidly increase in number to the point where they can take over the new environment, damaging native biodiversity. (Tamelander et al., 2010)

3. Impacts of Invasive Alien Species

Concern about invasions is not only limited to biodiversity, but it also extends to have ecological, socio-economic and human health related impacts.

3.1.Ecological Impacts

Many of non-native organisms compete with indigenous species for food and space. These organisms, sometimes, feed on the indigenous species, and their eggs, in the majority of cases. Consequently, the food chain and the local ecological system are negatively affected. Ecological impacts include loss of native biodiversity due to preying on or competing with native species, decreased habitat availability for native species, smothering and overgrowth as well as parasites and disease. For example, the American comb jelly introduced in the Black Sea is a voracious organism that preys on fish eggs and larvae. It spread rapidly due to the absence of natural predators to curb its multiplication. In the 1990s, it was believed that the American comb jelly was the reason behind the closure of fishing industries in the Black Sea. (Lawal, 2011)

3.2. Socio-economic Impacts

Economic impacts are manifested in the interference with biological resources that support fishing, interference with fisheries, disruption to tourism, damage to infrastructure and costs of treatment, the financial implication of cleaning up or control. Such as, discharged ballast water contains some species that may contaminate local filter-feeding shellfish. Such contamination may lead to the death of the shellfish or other local fish, causing fisheries to be closed, and subsequently the loss of numerous jobs and income. The closure of fisheries definitely has a negative effect on tourism, leading to grave socio-economic consequences. (Tamelander et al., 2010)

3.3. Impacts on Human Health

The introduced pathogens may cause diseases which sometimes lead to illness and eventual death. As a matter of fact, the spread of toxic phytoplankton and increasing occurrence of harmful algal blooms are of significant health concern. For example, on the
Mexican Pacific coast, the invasion of Paralytic Shellfish Poisoning caused by the introduced din flagellate, Gymnodiniumcatenatum, caused over 30 deaths, with nearly 500 people hospitalized. Moreover, cholera (Vibrio cholera) is known to mutate into new strains and travel widely in ship ballast water. The introduction of a virulent strain of cholera via ballast water from Asia resulted in a widespread cholera epidemic in
Peru in1991, causing thousands of health problems. (Tamelander et al., 2010)

4. The Ballast Water Management Convention (BWMC)

Ballast water management is defined as the "mechanical, physical, chemical, and biological processes, either singularly or in combination, to remove, render harmless, or avoid the uptake or discharge of Harmful Aquatic Organisms and Pathogens (HAOP) within Ballast Water and Sediments. (IMO, 2004)
In February 2004, the IMO adopted the International Convention for the Control and Management of Ships' Ballast Water and Sediments to regulate discharges of ballast water and reduce the risk of introducing non-native species transferred through ships' ballast water. The Convention will enter into force 12 months after ratification by at least 30 States, representing 35 % of world merchant shipping tonnage. (Lloyd's Register, 2015)

4.1. Overview of the Convention

The Convention is divided into 3 parts. First, it contains 22 articles including definitions and general obligations to flag and port States. Second, the Annex is divided into 5 sections. Section A comprises definitions of various terms under general provisions. Section B regulates management and control requirements for ships, whereas Section C makes provisions for special requirements in particular areas. Section D establishes standards for ballast water management, and Section E makes provisions for survey and certification requirements for ballast water management. Third and last part of the Convention is the Appendices, which contain samples of an International Ballast Water Certificate, and a Ballast Water Record Book. (Lawal, 2011)

The BWMC will enter into force one year after the date on which not less than 30 States representing 35 % of the gross tonnage of the world's merchant shipping have become party to it. As of 26th June 2015, 44 States representing 32.86% out of the requisite 35% of the world's merchant tonnage have ratified the Convention. According to Baltic and International Maritime Council (BIMCO)the states Argentina, Indonesia, Philippines, Belgium and Finland which representing more than 2% of the world fleet tonnage very close to ratify the convention so,the outstanding ratification is expected to be obtained shortly and the Convention will likely enter into force in 2016.

4.2. Application of the Convention

When the Convention enters into force, it not applies to all types of ships. First are those not designed to carry ballast water, which are known as “No Ballast On Board (NOBOB) ships. Second are ships with fixed ballast water in closed tanks not liable to discharge. Third are warships, naval auxiliaries or other ships owned or operated by a State and used for non-commercial service. Fourth are those ships that do not cross the borders between different countries. (Lawal, 2011)

4.3. General Obligations

Under Article 2 General Obligations, Parties endeavor to give full and complete effect to the provisions of the Convention and the Annex in order to prevent, reduce and ultimately eradicate the transfer of harmful aquatic organisms and pathogens through the control and management of ships’ ballast water and sediments. Parties are given the right to take, individually or jointly with other Parties, more binding measures with respect to the prevention, reduction or elimination of the transfer of harmful aquatic organisms and pathogens through the control and management of ships’ ballast water and sediments, consistent with international law. Furthermore, they must continually develop ballast water and sediment management practices and standards for the aim of combating the transfer of HAOP through them. (Tamelander et al., 2010)

Co-operation is mandated among parties to ensure effective implementation, compliance and enforcement of the Convention. In other words, they must collaborate under the guidance of IMO to address the jeopardy from HAOP as they affect the marine ecosystem and biodiversity within and beyond the limits of their national jurisdictions. When exercising their rights and obligations to enforce the Convention, including survey and certification, port and the flag States must strive hard to avoid any delay, or else compensation must be paid for any loss or damage occasioned.

In addition, the Convention demands that technical and technological support should be given to less capable States to facilitate implementation. States must, therefore, provide support to parties that request technical assistance to train personnel. They must be willing to launch joint research and development programs with them and make available to them relevant technology, equipment and infrastructures with the purpose of enhancing effective implementation of the Convention. Technical assistance may either be rendered directly or through IMO and other international bodies. Individually or jointly, parties are required to promote scientific and technical research on ballast water management, and also to monitor the effectiveness and adverse impacts of the adopted ballast water management technology and impacts caused by the organisms and pathogens identified as having being transported through ships’ ballast water. The results of the research and monitoring should be accessible to other parties upon request. (Lawal, 2011)

4.4. The Annex to the BWMC

Its Annex sets out the more detailed technical Regulations for the control and management of ships' ballast water and sediments. It is made up of five Sections: Section A sets outgeneral provisions, Section B includes management and control requirements for ships, Section C explains additional measures, Section D puts forward standards for ballast water management, and finally Section E comprises survey and certification requirements for Ballast Water Management.

5. Requirements for Ships

Ships are required to:

- Be surveyed and certified andmay be inspected by port State control officerswho can ascertain that the ship has a valid certificate,inspect the Ballast Water Record Book (BWRB) and insome situations, sample the ballast water. Nonetheless, allpossible efforts shall be made to avoidships being delayed.
- Have on board and implement a ballast water management plan approved by the Administration. The Plan is specific to each ship and includes a detailed description of the actions to be taken to implement the ballast water management demands and practices. (IMO, 2007).

The Ballast Water Management Plan is required to:

- Aid the ship in complying with international regulations to minimize the risk of the transfer of harmful aquatic organisms and pathogens in ships' ballast water and associated sediments;
- Identify the ship's Ballast Water Management Officer;
- Take into account ship safety elements, provide information to Port State Control (PSC) officers on the ship's ballast handling system and verify that ballast water management can be effectively planned;
- Comprise training on BWM operational practices; and
- Be written in the working language of the ship. If this language is not English, French or Spanish, a translation into one of these languages must be provided. (Lloyd's Register, 2015)

6. Beneficiaries of the BWMC

Parties to the BWM Convention will benefit from:

- Improved preservation of their marine environment and biodiversity through reducing and ultimately eradicating the adverse effects of IAS).
- Uniform implementation of Ballast Water Management Systems on foreign ships that enter ports.
- Taking part, through an established mechanism, in the process of suggesting amendments to the Convention.
- The various advantages of exchanging research and development information, practical experiences and best practices in the management of ballast water containing IAS.

Shipping industry will benefit from:

- Standardized international regime organizing ballast water management requirements as opposed to one-sided actions individual States.
- The encouragement provided by a uniform regime towards research and development to the effect of finding new and economic solutions to combat IAS.
- The development of innovative ballast water management technologies that are safe to the crew, cost-effective, and environmentally friendly. (IMO, 2007)

7. Ballast Water Treatment Processes

Because of its enormous ecological, economic and social implications, the ballast water issue is far more complex than most of the other ship-based pollution threats and requires advanced and fully integrated technological solutions. Generally, ballast water treatment processes are divided into two methods: separation or disinfection. By using the separation method, organisms from ballast water are removed upon intake or prior to discharge. As for disinfection, it kills or renders organisms unable to reproduce. Ballast Water Management Systems (BWMS) have been developed using various combinations of methods. (ABS, 2014)

7.1.Separation

Put simply, solid-liquid separation is the separation of suspended solid material, including the larger suspended microorganisms, from the ballast water, either by sedimentation (allowing the solids to gradually sink by virtue of their own weight) or by surface filtration. Filtration is the passage of a fluid through a porous medium, with a filtering material smaller in size than that of the particle or organism, to remove suspended matter, such as sediment, organisms, and silt. (Lloyd's Register, 2015)

7.2. Disinfection

An important aspect of ballast water management is the destruction of invasive organisms. Disinfection can kill or alter alien organisms such that they cannot reproduce or are no longer viable. Among the several disinfection technologies used in BWMS are chlorination, ozone treatment, de-oxygenation, and ultraviolet (UV) treatment. The ability for technologies to be effective disinfectants is affected by the salinity and turbidity of the seawater.

Chlorination is a traditional technique for waste water disinfection and can be accomplished through conversion of naturally existing chlorine in seawater or direct injection of chlorine-containing compounds. In electrolytic chlorination (i.e., electrolysis), an electrical current is directly applied to seawater generating free chlorine, sodium hypochlorite and hydroxyl radicals. During the electrolytic chlorination process, a certain salinity level in ballast water is required or additional salt will need to be added. The hydroxyl radicals generated in seawater quickly form disinfection byproducts – like hypobromous acid, a highly effective biocide or germicide. (ABS, 2014)

Disinfection removes or inactivates micro-organisms using one or more of the following methods:

- Chemical inactivation of the micro-organisms through either:

Oxidizing biocides – general disinfectants which destroy organic structures, such as cell membranes or nucleic acids; or non-oxidizing biocides – these disrupt reproductive, neural, or metabolic functions of the organisms.

- Physicochemical inactivation of the micro-organisms through processes such as UV light, heat or cavitations.
- Asphyxiation of the micro-organisms through de-oxygenation. (Lloyd's Register, 2015)

8. Conclusion

The BWMC is the first inclusive and international mandatory legal regime that specifically addresses and attempts to find a comprehensive solution to the problem of HAOP transferred through ships' ballast water. In this concern, it is more enhanced than the Regulations and Guidelines that preceded it. Because of its mandatory nature, Parties to the Convention will have to comply with its minimum ballast water management standards. By so doing, this would promote stability and uniform development of the legal regime on controlling the transfer of HAOP through ships' ballast water and sediments. The Convention, therefore, would ensure the prevention of conflict between the respective requirements of the States.

Nevertheless, the greatest challenges for the Convention to come into force. Once this happens, the duty for States to partner and co-operate to implement its provisions would have a chance of being achieved. Developing State parties, in that case, may benefit from financial and technical assistance to help them begin to meeting their obligations under the purview of the Convention. It must be emphasized that such co-operation and extension of assistance is crucial so that as many States as possible can ably join to work together so as to prevent the transfer of HAOP carried around in ships' ballast water.

The adoption of the BWMC is an important global step in the journey to control and eliminate the transfer of HAOP through ships' ballast water and sediments. When the Convention eventually comes into force and efforts are exerted to implement its provisions and Regulations on a large scale, it will offer a capable legal approach for effective regulatory prevention of activities that promote the transfer of HAOP. Under its auspices, hopefully, the objective of preventing, reducing and ultimately eradicating the risks to the environment, human health, property and resources resulting from the transfer of HAOP through the control and management of ships' ballast water and sediments shall be realized. The international community, thus, would enjoy a marine environment that is free from the threat posed by HAOP introduced into different coastal regions by ships' ballast water and sediments and safer marine ecosystems devoid of HAOP will be ensured in due time.

The impacts of the transfer of harmful aquatic organisms and pathogens (HAOP) through ships' ballast water and sediments are devastating. These effects are ecological, economic, environmental and human health effects. To combat the problem, the international community under the auspices of various organizations (such as, the United Nations (UN) and in particular, the IMO) has adopted various international instruments. The majority of the binding instruments is not directed principally to combating the transfer of HAOP associated with ships' ballast water and sediments, but rather establishes basic provisions to prevent the problem.

9. Recommendation

- The Egyptian government should start inspecting its own ships to make sure that they conform to the Regulations set by the BWMC.

- Prior to the Convention's entry into force, the Egyptian government should ensure the preparedness of the port State control officers to inspect the ships that enter the Egyptian ports

- As for the States (Argentina, Indonesia, Philippines, Belgium and Finland, representing more than 2% of the world fleet tonnage needed to put the Convention into force) whose ratification is in progress, they should promptly become Party to the Convention.

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